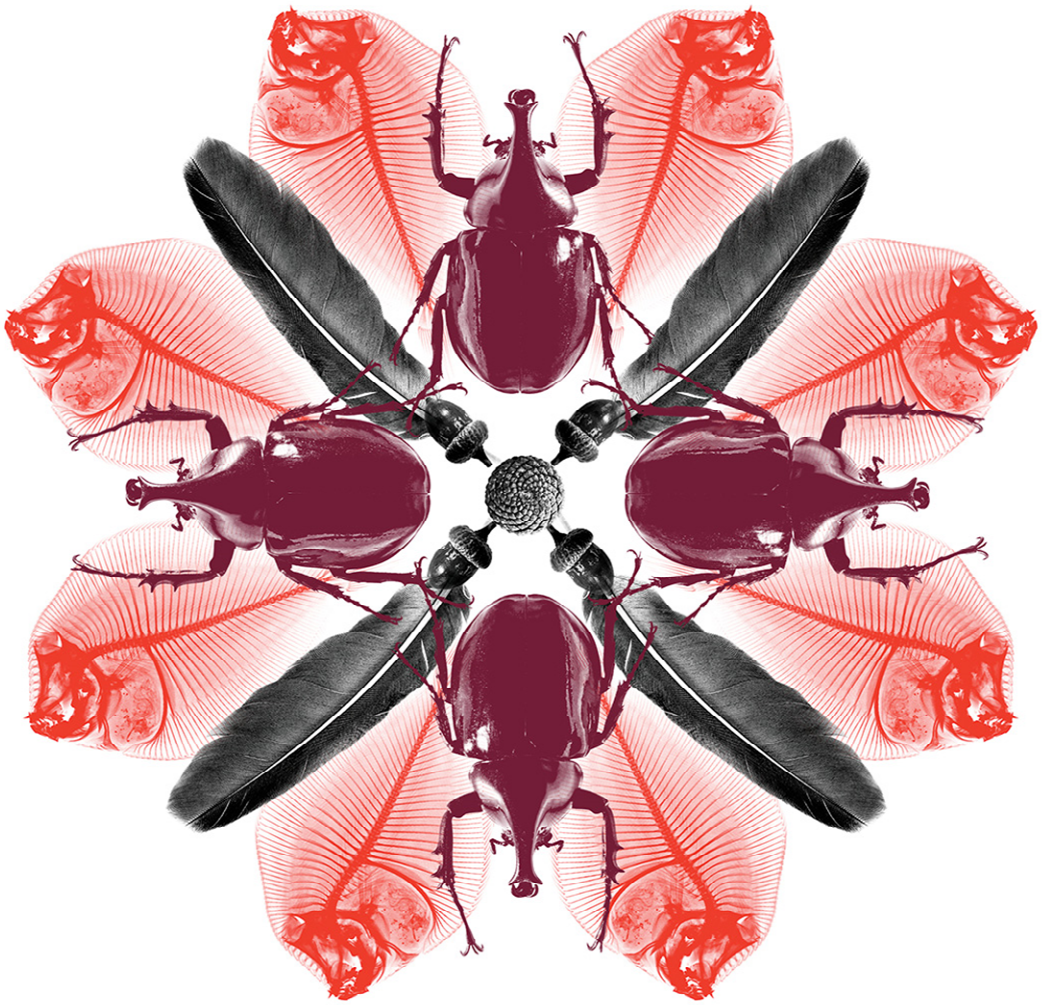
Australian Government
Department of Agriculture, Water and the Environment

Final risk analysis report for the release of *Hydrotimetes natans* for the biological control of *Cabomba caroliniana*

February 2021



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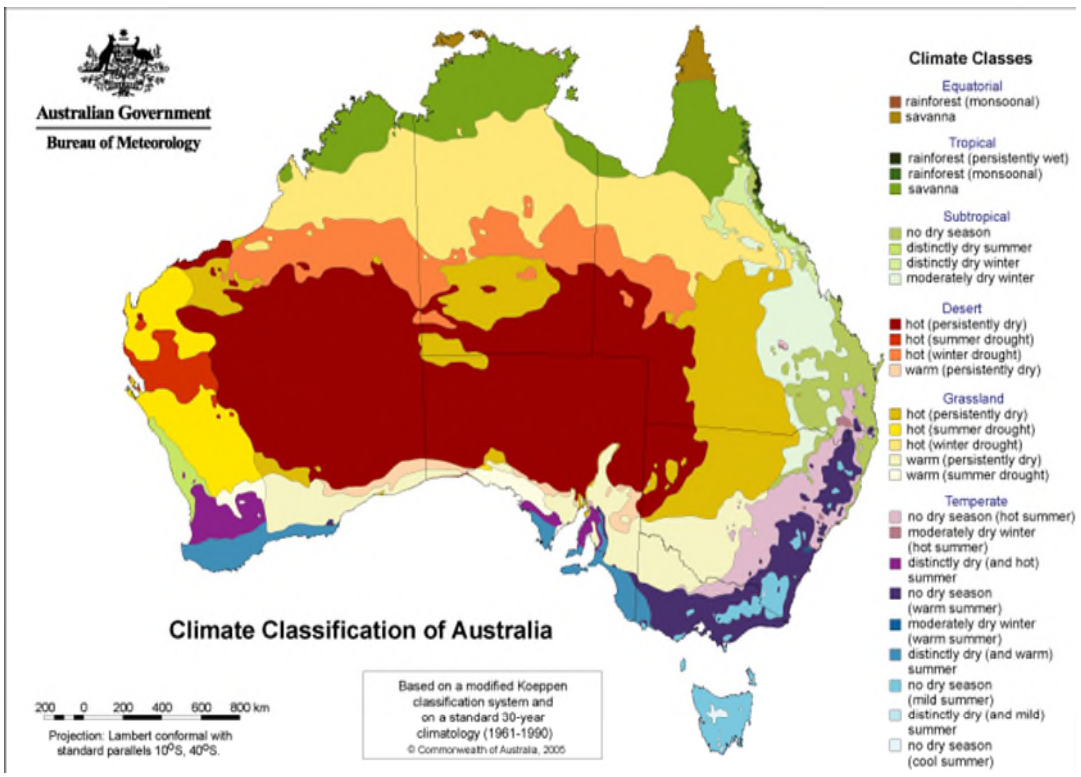

Acronyms and abbreviations

Term or abbreviation	Definition
ACT	Australian Capital Territory
ALOP	Appropriate level of protection
BA	Biosecurity Advice
BCA	Biological Control Agent
BICON	The Australian Department of Agriculture, Water and the Environment Biosecurity Import Conditions database
BIRA	Biosecurity Import Risk Analysis
CSIRO	Commonwealth Scientific and Industrial Research Organisation
FAO	Food and Agriculture Organization of the United Nations
IPC	International Phytosanitary Certificate
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
NSW	New South Wales
NPPO	National Plant Protection Organisation
NT	Northern Territory
PRA	Pest risk assessment
Qld	Queensland
SA	South Australia
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
Tas.	Tasmania
the department	The Australian Government Department of Agriculture, Water and the Environment
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organization

Summary

The Australian Government Department of Agriculture, Water and the Environment has prepared this final report to assess the proposal by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to release *Hydrotimetes natans* for the biological control of *Cabomba caroliniana* in Australia.

This final report recommends that the release of *H. natans* should be permitted, subject to standard quarantine conditions associated with the import and release of exotic biological control agents.

This final report has determined the overall risk associated with the release of *H. natans* to be Negligible. A risk estimate of Negligible achieves Australia's appropriate level of protection (ALOP).

The assessment of risk to off-target plants included consideration of the testing methodology used and the plant species test list, including non-target species tested in described experiments. The biology of *H. natans* was also considered.

This final report also contains details of the risk assessment process used for consideration of potential off-target effects associated with the proposed release of *H. natans*.

There is also an approval process for the import and release of biological control agents under the *Environment Protection and Biodiversity Conservation Act 1999* within the department. The approval process under that Act will commence upon finalisation of this risk analysis process.

The application from CSIRO that was provided to the department has been included with this final report (Attachment 1).

1 Introduction

1.1 Australia's biosecurity policy framework

Australia's biosecurity policies aim to protect Australia against the risks that may arise from exotic pests entering, establishing and spreading in Australia, thereby threatening Australia's unique flora and fauna, as well as those agricultural industries that are relatively free from serious pests.

The risk analysis process is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the level of biosecurity risk that may be associated with proposals to import goods or biological materials into Australia. If the biosecurity risks do not achieve the appropriate level of protection (ALOP) for Australia, risk management measures are proposed to reduce the risks to an acceptable level. If the risks cannot be reduced to an acceptable level, the goods or biological materials will not be imported into Australia until suitable measures are identified.

Successive Australian Governments have maintained a stringent, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of the ALOP for Australia, which is defined in the *Biosecurity Act 2015* as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Australia's risk analyses are undertaken by the Australian Government Department of Agriculture, Water and the Environment using technical and scientific experts in relevant fields, and involve consultation with stakeholders at various stages during the process.

Further information about Australia's biosecurity framework is provided in the *Biosecurity Import Risk Analysis Guidelines 2016* located on the Australian Government Department of Agriculture, Water and the Environment website.

1.2 This risk analysis

1.2.1 Background

An application has been submitted by CSIRO to release a biological control agent (Attachment 1). The identified biological control agent, *Hydrotimetes natans* is a weevil proposed for the biological control of the aquatic weed, *Cabomba caroliniana*. The applicant has followed the steps outlined in the Biosecurity Guidelines for the Introduction of Exotic Biological Control Agents for the Control of Weeds and Plant Pests.

Cabomba caroliniana is an aquatic weed of permanent and slow-moving freshwater bodies in Australia. It is distributed along the east coast from north Queensland to Victoria, with some infestations also being found in the Northern Territory near Darwin. This species is native to South America. *Cabomba caroliniana* is a Weed of National Significance (WONS) in Australia. It forms dense monocultures, reducing light availability and displacing other vegetation in water bodies. It is a contaminant of dams supplying drinking water and agriculture and also negatively affects recreational activity such as swimming and boating in water bodies it infests. Control is costly and difficult – chemicals are difficult to apply as it is a submerged plant and restrictions

also apply to the use of herbicides in water bodies. Other control techniques, with various levels of success, include mechanical control, drying via lowering the water level and shading (Attachment 1).

Hydrotimetes natans is a weevil native to South America. The most damaging life stage to *C. caroliniana* are the larvae, which mine the stems, causing extensive damage. The adult weevils feed on the tips and stems of the plant but only cause limited damage (Attachment 1).

1.2.2 Scope

The scope of this risk analysis is to consider the biosecurity risk that may be associated with the release of an exotic biological control agent into the Australian environment (excluding its external territories). The primary risk associated with a release of this nature is the possibility of unwanted off-target effects on other species already present in Australia. The Department of Agriculture, Water and the Environment assesses the risk under the *Biosecurity Act 2015*. There is also an approval process within the department under the *Environment Protection and Biodiversity Conservation Act 1999*. Under section 303EE(4) of the *Environment Protection and Biodiversity Conservation Act 1999*, risk analysis reports prepared by the department may be used by the Minister for the Environment in making a determination to include the species on the *List of specimens taken to be suitable for live import*.

Plants that are considered weeds are sometimes also considered to have value, for example, for purposes such as ornamental display, traditional medicine, feed for stock, etc. Considerations of the benefits, and therefore any associated concerns about eradication of the target weed species are out of the scope of this analysis.

The Department of Agriculture, Water and the Environment will not commence an assessment to release a biological control agent unless the target has been approved by an appropriate government body. *Cabomba caroliniana* was approved by the former Natural Resource Management Standing Committee (NRMSC) in November 2006.

1.2.3 Associated pests

There are pests that may arrive with an imported exotic biological control agent. Section 9 of the *Biosecurity Act 2015* defines a pest as 'a species, strain or biotype of plant or animal, or a disease agent, that has the potential to cause, either directly or indirectly, harm to: human, animal or plant health; or the environment.' These pests may include, for example, parasitoids, mites or fungi. Should an application to release a biological control agent be approved, these pests will be addressed by existing operational procedures that apply to the importation and final release of the agent. These procedures include detailed examination of imported material, confirmation of identity, and breeding under containment conditions before release. For this reason, associated pests are not further considered in this risk analysis.

1.2.4 Consultation

In August 2020, a preliminary draft of this report was distributed to state and territory departments of primary industry via the Plant Health Committee. Comments were considered and some minor changes were made to the application as a result. The draft report incorporated suggested changes made to the likelihood of off-target effects and consequences sections. There

was no change to the off-target risk estimate of Negligible and no objections to the proposed recommendation to release *H. natans* for the biological control of the weed *C. caroliniana.*

On 12 November 2020, Biosecurity Advice 2020/P12 informed stakeholders of the release of a draft risk analysis report for the release of *H. natans* for the biological control of the weed *C. caroliniana*. The draft report was released for a 30 day stakeholder consultation period that closed on 12 December 2020. One stakeholder submission was received; the submission supported the release of *H. natans*.

1.2.5 Next Steps

Publication of the final report represents the end of the risk analysis process. There is also an approval process within the department under the *Environment Protection and Biodiversity Conservation Act 1999*. Risk analysis reports may be used by the Minister for the Environment in making a determination to include the species on the *List of specimens taken to be suitable for live import* (the Live Import List). This approval process will now take place. If the Department of Agriculture, Water and the Environment approves release of the biological control agent and the Live Import List is amended to include the agent, a letter will be sent to the applicant providing conditions of release.

2 Assessment of off-target risks

This section sets out the assessment of off-target risks that could be associated with the release of the biological control agent. Where appropriate, the methods followed those used for pest risk analysis (PRA) by the Department of Agriculture, Water and the Environment in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO 2019a), ISPM 3: *Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms* (FAO 2017) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO 2019c) that have been developed under the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) (WTO 1995). The methodology for a commodity-based PRA is provided in Appendix A.

The SPS Agreement defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Like many other countries, Australia expresses its ALOP in qualitative terms. The ALOP for Australia, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 2.1, marked 'very low risk', represents the upper boundary of the ALOP for Australia.

The risk associated with the release of a biological control agent is a combination of the estimates of likelihood of off-target effects and the potential consequences of any off-target effects. A risk estimation matrix (Table 2.1) is used to combine these estimates.

Table 2.1 Risk estimation matrix.

Likelihood of off-target effects	Consequences of off-target effects					
	Negligible	Very low	Low	Moderate	High	Extreme
High	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
Negligible	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

2.1 Stage 1: Initiation

Initiation commences when an applicant provides a submission proposing the release of a biological control agent. The Department of Agriculture, Water and the Environment will not commence an assessment to release a biological control agent unless the target pest in the submission has been approved as a biological control target by an appropriate government body.

The risk analysis area is defined as all of Australia (excluding its external territories), given that once released there will be no control of spread of the agent other than environmental constraints related to the biology of the organism.

2.2 Stage 2: Risk assessment

This assessment evaluates the likelihood of off-target effects and the potential economic and environmental consequences of any such effects.

The risk assessment is based primarily on consideration of the information provided by the applicant in the application package, including the results of host specificity testing, and current information in the scientific literature, where this is available. Given that the proposal is for deliberate release, the likelihood of entry, establishment and spread is assumed to be certain, and therefore the assessment relates to the host specificity of the proposed agent.

A likelihood is assigned to the estimate of occurrence of off-target effects. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible. Definitions for these descriptors and their indicative ranges are given in Appendix A, Table 1.

2.2.1 Host specificity testing methodology

The following summarised information regarding host specificity testing has been sourced from the application provided by CSIRO (Attachment 1). For further details please refer to the application.

In order to determine whether any non-target species would be at risk from the candidate agent, host specificity tests were conducted with *H. natans* under quarantine containment conditions in Australia and in Argentina. The applicant conducted host specificity tests on a total of 17 plant species, including the target, *C. caroliniana* (Attachment 1, Table 1). The standard phylogenetic approach for test list species selection, where closely related species within the target species' family are tested, was followed (Briese 2005). Three of the 17 plant species tested were only tested during pilot studies in Argentina, and did not undergo comprehensive host specificity testing in Australia. These three species are not present in Australia. *Cabomba caroliniana* belongs to the family Cabombaceae, within the order Nymphaeales. Within Australia there are only two species present in the family Cabombaceae, the target weed, *C. caroliniana* and the native, non-endemic species, *Brasenia schreberi*. *Brasenia schreberi* was included in testing. There are only two other families in the order Nymphaeales, these are Nymphaeaceae and Hydatellaceae and representatives from each of these families, including native and exotic species, were included in testing.

Test plants were sourced as corms from commercial growers or sourced from the field from natural water bodies.

Host specificity testing in this application involved several experimental methods. Testing consisted of pilot studies - conducted in Argentina and in quarantine in Australia, comprehensive no-choice testing, choice testing and continuation trials. Choice testing and continuation trials were only carried out on species on which *H. natans* development was recorded in no-choice trials (*Brasenia schreberi* only).

Pilot studies

Pilot studies were undertaken to gather preliminary information on whether adult *H. natans* would feed on off-target species and to observe feeding behaviour. For Australian trials, cut leaf discs were used (except for *N. nouchali* and *C. caroliniana* due to small leaf size). These were kept in a container with slightly acidic water and a pair of adult *H. natans* was released into each container. After 10 days, leaves were examined for feeding damage. Six replicates per plant species were carried out. In addition to the target weed, *B. schreberi* and four *Nymphaea* species were tested. Experiments in Argentina are reported as being similar to the Australian trials however specifics were not provided. The Argentinian trials included the target weed, three species not present in Australia (*C. caroliniana* var. *flavida*, *N. prolifera* and *Victoria cruziana*) and *N. caerulea*. With the exception of the target weed, *N. caerulea* was the only species tested in both Australia and Argentina.

Comprehensive testing

For comprehensive host specificity testing in Australia, a life-history based testing approach was used. The applicant explained that this is where only observations that could be recorded without destructive sampling were made. This was necessary because the majority of the lifecycle of *H. natans* is under water and oviposition sites and damage caused by 1st and 2nd instar larvae cannot be examined without destructive sampling. The target weed and test plants are fragile and would have been damaged by constant removal from the water for examination. Therefore, these trials focussed on documenting the likelihood of lifecycle completion on plant species and observations on adult and larval feeding and larval development were left until the end of each test when dissections were made. The only exception to this was observations for oviposition being made *in situ* during the tests, taking care not to damage plants.

No-choice, choice and continuation trial testing was carried out in a temperature and humidity controlled glasshouse, maintained at 27°C ± 4°C with a relative humidity of approximately 40%. Whole potted plants in crates filled with reverse osmosis water were used. Each no-choice and choice trial ran for greater than 42 days, to correspond with the duration of the life-cycle of *H. natans* and multiple trials were run over 3 years to complete the testing.

No-choice tests

Numbers of plants used in each test depended on the relative sizes of the plants and the experimental arenas used; for example, for tests of *Nymphaea* species a single plant was used with two control (*C. caroliniana*) plants, as the *Nymphaea* species are much larger. For tests of *Trithuria* species a single plant of both test species and control were used.

Test plant species were tested in six replicates, with the exception of *T. austinensis* (3 replicates) and *T. fitzgeraldii* (4 replicates). Each replicate for the control and test species was allocated six paired (ie. 3 females and 3 males) adult *H. natans*.

Choice tests

For choice trials with *B. schreberi*, potted plants of both test and control species were maintained together in a single crate. Five replicates were tested. Each replicate (one control and one test plant species) was allocated six paired (ie. 3 females and 3 males) adult *H. natans*.

Continuation trials

For continuation trials with *B. schreberi*, two potted plants of this species were maintained in a crate and additional plants provided as required to ensure that host plant availability wasn't a limiting factor for life-cycle completion. Four replicates were tested. Each replicate was allocated six paired (ie. 3 females and 3 males) adult *H. natans*. The trial was run for approximately 150 days (this corresponds to the developmental time for three generations of *H. natans*).

Observations on oviposition were made three times per week, throughout the duration of each replicate, for no-choice, choice and continuation trials. At the end of each testing period all plant material was examined microscopically. Observations were made on the presence of adult feeding and number of adult feeding scars, presence of oviposition, presence of larval feeding, number of pupae formed and number of adults emerged.

2.2.2 Host specificity testing results

Pilot studies

During Australian trials, feeding lesions were observed on all plant species tested except *N. mexicana*. The applicant reports that the feeding observed was exploratory and that although the average number of feeding scars was greater on *B. schreberi* than *C. caroliniana*, the means were not statistically different.

The applicant reports that similar trials were conducted in Argentina. Superficial feeding was recorded by adults, with extensive damage being reported on both *C. caroliniana* varieties. Larval feeding and survival was recorded on some species, but not on either of the *Nymphaea* species tested. It was reported that all larvae died within four or five days on non-target plants.

The results of the pilot studies conducted in Argentina and Australia were not included in the results of host specificity testing.

No-choice tests

Adult feeding was observed on *C. caroliniana*, *B. schreberi* and some replicates of four of the seven tested *Nymphaea* species (*N. gigantea*, *N. immutabilis*, *N. pubescens* and *N. violacea*). No oviposition or development was recorded on the four species of *Nymphaea* that supported adult feeding. Adult feeding on *C. caroliniana* was far greater than that observed on *B. schreberi* and any of the *Nymphaea* species. The remaining *Nymphaea* species and all *Trithuria* species sustained no adult feeding, no oviposition, and therefore no development.

Oviposition and lifecycle development of *H. natans* was observed on *B. schreberi*. Oviposition was recorded on four out of six replicates and larval feeding on three out of six replicates. Development of larvae through to pupation and lifecycle completion was only observed on one replicate. *Cabomba caroliniana* supported lifecycle completion on all replicates.

Choice tests

As lifecycle completion was recorded on one replicate of *B. schreberi* during no-choice testing, choice tests were conducted with *B. schreberi* and *C. caroliniana*. Oviposition and larval development on *B. schreberi* were recorded on two of the five replicates tested. Pupation was recorded on one replicate (two pupae) but there was no lifecycle completion of *H. natans* recorded. *Cabomba caroliniana* supported lifecycle completion on all replicates.

Continuation trials

Of the four *B. schreberi* replicates, tested over approximately 150 days, oviposition was observed on three replicates. Larval development and pupation was recorded on one replicate, and from the single pupa recorded on that replicate an adult emerged.

2.2.3 Comments on host specificity testing

The reported results of the host specificity testing consistently showed lifecycle completion and damage to the target weed by *H. natans* within all replicates across all tests. Oviposition and larval development was recorded on *B. schreberi* in some replicates across both no-choice and choice tests, however lifecycle completion was only recorded in one replicate in both no-choice tests and continuation trials. A population was unable to be sustained on *B. schreberi*, with only one adult emerging during the three generations that the continuation trial was run. *Brasenia schreberi* is the only other species within the Cabombaceae family present in Australia. Testing on representative species from the Nymphaeaceae and Hydatellaceae families resulted in no oviposition on any species tested. While some adult feeding occurred during no-choice trials on some replicates of *B. schreberi* and four *Nymphaea* species, the applicant notes that this feeding was negligible compared to adult feeding on *C. caroliniana*. It is also noted that larval feeding is the damaging stage of *H. natans*, adult feeding is not reported to have a major impact on *C. caroliniana*.

In addition to host specificity testing, field surveys were undertaken for two months in the native range of *H. natans*. Observations were made on the presence of *H. natans* and feeding damage on non-target plant species at four sites, one in Argentina and three in Paraguay. *Hydrotimetes natans* was primarily found on *C. caroliniana*, with one record on *N. prolifera*, however no feeding damage was observed on *N. prolifera*. These survey observations add confidence to the outcomes of the laboratory-based host specificity testing done in Australia.

2.2.4 Likelihood of off-target effects

The likelihood of off-target effects is estimated on the basis of the outcomes of host specificity testing and other relevant information presented in the application (Attachment 1).

Host specificity testing results indicate that *H. natans* is host specific to *C. caroliniana*. Minimal development occurred on the most closely related species in Australia, *B. schreberi* and testing results, including continuation trials, indicate that this species is not a suitable host. It is possible

however that there may be some minor adult and larval feeding where *B. schreberi* is in close proximity to *C. caroliniana*. None of the other species tested are expected to be at risk of off-target impacts from *H. natans*.

On the basis of the results of host specificity testing reported in this application, it is concluded that the likelihood of occurrence of off-target effects in Australia is **Low**.

2.2.5 Assessment of potential consequences of off-target effects

The potential consequences of the off-target effects of this biological control agent have been assessed using the same methodology (Appendix A) as used in the import risk analysis process for pests associated with imported fresh produce.

Criterion	Estimate and rationale
Direct	
Plant life or health	A—indiscernible It is not anticipated that there will be any discernible off-target effects associated with the release of *H. natans* due to the high level of host specificity demonstrated during testing. If any off-target effects were to occur this would most likely take the form of minor adult and larval feeding on *B. schreberi*. The applicant predicts that based on bioclimatic models, *H. natans* is likely to be restricted to subtropical and tropical areas of Australia and is therefore only expected to have a biogeographic overlap with populations of *B. schreberi* in these areas. *Brasenia schreberi* occurs in greater abundance in temperate areas of Australia. Any off-target feeding is predicted to be indiscernible at the local level.
Other aspects of the environment	A—indiscernible No negative direct impacts on other aspects of the environment are anticipated. Reduction of *C. caroliniana* would result in clearer waterways in affected areas and less herbicide usage.
Indirect	
Eradication, control	A—indiscernible *Hydrotimetes natans* is a biological control agent proposed for release for the biological control of *C. caroliniana*, a weed of economic importance. The likelihood of occurrence of off-target effects is predicted to be very low. If minor off-target feeding were to occur it would not result in plant death or affect viability and therefore *H. natans* would be very unlikely to subsequently require attempted eradication or control.
Domestic trade	A—indiscernible *Hydrotimetes natans* is a biological control agent proposed for release for the biological control of *C. caroliniana*, a weed of economic importance. If minor off-target feeding were to occur on *B. schreberi* this is unlikely to affect domestic trade. The applicant has noted that *B. schreberi* is of minor importance in the aquarium and ornamental sectors.
International trade	A—indiscernible *Hydrotimetes natans* is a biological control agent proposed for release for the biological control of *C. caroliniana*, a weed of economic importance. No off-target impacts are expected to occur on any plant species of significance to international trade.
Environmental and non-commercial	A—indiscernible

	Cabomba caroliniana is an introduced and invasive weed in Australia. It is expected that any off-target effects on other species would be limited to minor feeding on *B. schreberi*, which would not be anticipated to affect plant health, and therefore, no indirect environmental or non-commercial impacts are expected.

Based on this assessment the potential consequences of off-target effects are assessed as: **Negligible**.

2.2.6 Off-target risk estimate

Unrestricted risk is the result of combining the likelihood of off-target effects with the outcome of potential consequences. Off-target effects and consequences are combined using the risk estimation matrix shown in Table 2.1.

Risk estimate for *Hydrotimetes natans*	
Likelihood of off-target effects	Low
Consequences	Negligible
Risk	Negligible

As indicated, the risk estimate for release of *Hydrotimetes natans* has been assessed as 'Negligible', which achieves the appropriate level of protection (ALOP) for Australia.

3 Recommendation on release

The overall risk estimate for release of *H. natans* has been assessed as Negligible, which achieves the ALOP for Australia. Therefore, it is recommended that this biological control agent be permitted to be released, subject to standard import and release conditions to ensure that the released material is free of other organisms.

This recommendation is made on the basis of the high level of host specificity demonstrated by *H. natans* on *C. caroliniana*, and is based on currently available information.

4 Stakeholder responses to draft risk analysis report

One stakeholder submission was received, from the Western Australian Department of Primary Industries and Regional Development (DPIRD). The outcomes of the report were supported by DPIRD, noting the minimal off-target impact on other related plant species.

5 Attachment 1

Attachment 1 - Application to release the cabomba weevil *Hydrotimetes natans* for the biological control of *Cabomba caroliniana* in Australia.

Appendix A: Method for pest risk analysis

This chapter sets out the method used for the pest risk analysis (PRA) in this report. The Department of Agriculture, Water and the Environment has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for pest risk analysis* (FAO, 2019a) and ISPM 11: *Pest risk analysis for quarantine pests* (FAO, 2019c) that have been developed under the SPS Agreement (WTO, 1995).

A PRA is 'the process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it' (FAO, 2019b). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products' (FAO, 2019b). This definition is also applied in the *Biosecurity Act 2015*.

Biosecurity risk consists of two major components: the likelihood of a pest entering, establishing and spreading in Australia from imports; and the consequences should this happen. These two components are combined to give an overall estimate of the risk.

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, the department will verify that the consignment received is as described on the commercial documents and its integrity has been maintained.

Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is 'any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests' (FAO, 2019b).

A glossary of the terms used in the risk analysis is provided at the end of this report.

The PRAs are conducted in the following three consecutive stages: initiation, pest risk assessment and pest risk management.

Stage 1 Initiation

Initiation identifies the pest(s) and pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

For this risk analysis, the 'PRA area' is defined as Australia for pests that are absent, or of limited distribution and under official control. For areas with regional freedom from a pest, the 'PRA area' may be defined on the basis of a state or territory of Australia or may be defined as a region of Australia consisting of parts of a state or territory or several states or territories.

For pests that had been considered by the department in other risk assessments and for which import conditions already exist, this risk analysis considered the likelihood of entry of pests on the commodity and whether existing policy is adequate to manage the risks associated with its import. Where appropriate, the previous risk assessment was taken into consideration in this risk analysis.

Stage 2 Pest risk assessment

A pest risk assessment (for quarantine pests) is the 'evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences' (FAO, 2019b).

The following three, consecutive steps were used in pest risk assessment:

Pest categorisation

Pest categorisation identifies which of the pests with the potential to be on the commodity are quarantine pests for Australia and require pest risk assessment. A 'quarantine pest' is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO, 2019b).

The pests identified in Stage 1 were categorised using the following primary elements to identify the quarantine pests for the commodity being assessed:

- identity of the pest
- presence or absence in the PRA area
- regulatory status
- potential for establishment and spread in the PRA area
- potential for economic consequences (including environmental consequences) in the PRA area.

Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO, 2019c). The SPS Agreement (WTO 1995) uses the term 'likelihood' rather than 'probability' for these estimates. In qualitative PRAs, the department uses the term 'likelihood' for the descriptors it uses for its estimates of likelihood of entry, establishment and spread. The use of the term 'probability' is limited to the direct quotation of ISPM definitions.

A summary of this process is given here, followed by a description of the qualitative methodology used in this risk analysis.

Likelihood of entry

The likelihood of entry describes the likelihood that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state in the PRA area and subsequently be transferred to a host. It is based on pathway scenarios depicting necessary steps in the sourcing of the commodity for export, its processing, transport and storage, its use in Australia and the generation and disposal of waste. In particular, the ability of the pest to survive is considered for each of these various stages.

The likelihood of entry estimates for the quarantine pests for a commodity are based on the use of the existing commercial production, packaging and shipping practices of the exporting country. Details of the existing commercial production practices for the commodity are set out in

the report. These practices are taken into consideration by the department when estimating the likelihood of entry.

For the purpose of considering the likelihood of entry, the department divides this step into two components:

- **Likelihood of importation**—the likelihood that a pest will arrive in Australia when a given commodity is imported.
- **Likelihood of distribution**— the likelihood that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Factors to be considered in the likelihood of importation may include:

- distribution and incidence of the pest in the source area
- occurrence of the pest in a life-stage that would be associated with the commodity
- mode of trade (for example, bulk, packed)
- volume and frequency of movement of the commodity along each pathway
- seasonal timing of imports
- pest management, cultural and commercial procedures applied at the place of origin
- speed of transport and conditions of storage compared with the duration of the lifecycle of the pest
- vulnerability of the life-stages of the pest during transport or storage
- incidence of the pest likely to be associated with a consignment
- commercial procedures (for example, refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors to be considered in the likelihood of distribution may include:

- commercial procedures (for example, refrigeration) applied to consignments during distribution in Australia
- dispersal mechanisms of the pest, including vectors, to allow movement from the pathway to a host
- whether the imported commodity is to be sent to a few or many destination points in the PRA area
- proximity of entry, transit and destination points to hosts
- time of year at which import takes place
- intended use of the commodity (for example, for planting, processing or consumption)
- risks from by-products and waste.

Likelihood of establishment

Establishment is defined as the 'perpetuation for the foreseeable future, of a pest within an area after entry' (FAO, 2019b). In order to estimate the likelihood of establishment of a pest, reliable biological information (for example, lifecycle, host range, epidemiology, survival) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the likelihood of establishment.

Factors to be considered in the likelihood of establishment in the PRA area may include:

- availability of hosts, alternative hosts and vectors
- suitability of the environment
- reproductive strategy and potential for adaptation
- minimum population needed for establishment
- cultural practices and control measures.

Likelihood of spread

Spread is defined as 'the expansion of the geographical distribution of a pest within an area' (FAO, 2019b). The likelihood of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the likelihood of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the likelihood of spread.

Factors to be considered in the likelihood of spread may include:

- suitability of the natural and/or managed environment for natural spread of the pest
- presence of natural barriers
- potential for movement with commodities, conveyances or by vectors
- intended use of the commodity
- potential vectors of the pest in the PRA area
- potential natural enemies of the pest in the PRA area.

Assigning likelihoods for entry, establishment and spread

Likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 1). Definitions for these descriptors and their indicative probability ranges are given in Table 1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors and are not used beyond this purpose in qualitative PRAs. These indicative probability ranges provide guidance to the risk analyst and promote consistency between different pest risk assessments.

Table 1 Nomenclature of likelihoods

Likelihood	Descriptive definition	Indicative range
High	The event would be very likely to occur	0.7 < to ≤ 1
Moderate	The event would occur with an even likelihood	0.3 < to ≤ 0.7
Low	The event would be unlikely to occur	0.05 < to ≤ 0.3
Very low	The event would be very unlikely to occur	0.001 < to ≤ 0.05
Extremely low	The event would be extremely unlikely to occur	0.000001 < to ≤ 0.001
Negligible	The event would almost certainly not occur	0 < to ≤ 0.000001

Combining likelihoods

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the likelihood of importation is assigned a descriptor of 'low' and the likelihood of distribution is assigned a descriptor of 'moderate', then they are combined to give a likelihood of 'low' for entry. The likelihood for entry is then combined with the likelihood assigned for establishment of 'high' to give a likelihood for entry and establishment of 'low'. The likelihood for entry and establishment is then combined with the likelihood assigned for spread of 'very low' to give the overall likelihood for entry, establishment and spread of 'very low'. This can be summarised as:

importation x distribution = entry [E]	**low x moderate = low**
entry x establishment = [EE]	**low x high = low**
[EE] x spread = [EES]	**low x very low = very low**

Table 2 Matrix of rules for combining likelihoods

	High	Moderate	Low	Very low	Extremely low	Negligible
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate		Low	Low	Very low	Extremely low	Negligible
Low			Very low	Very low	Extremely low	Negligible
Very low				Extremely low	Extremely low	Negligible
Extremely low					Negligible	Negligible
Negligible						Negligible

Time and volume of trade

One factor affecting the likelihood of entry is the volume and duration of trade. If all other conditions remain the same, the overall likelihood of entry will increase as time passes and the overall volume of trade increases.

The department normally considers the likelihood of entry on the basis of the estimated volume of one year's trade. This is a convenient value for the analysis that is relatively easy to estimate and allows for expert consideration of seasonal variations in pest presence, incidence and behaviour to be taken into account. The consideration of the likelihood of entry, establishment and spread and subsequent consequences takes into account events that might happen over a number of years even though only one year's volume of trade is being considered. This difference reflects biological and ecological facts, for example where a pest or disease may establish in the year of import but spread may take many years.

The use of a one year volume of trade has been taken into account when setting up the matrix that is used to estimate the risk and therefore any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on the department's method that uses the estimated volume of one year's trade are consistent with Australia's policy on appropriate level of protection and meet the Australian Government's requirement for ongoing quarantine protection. If there are substantial changes in the volume and nature of the trade in specific commodities then the department will review the risk analysis and, if necessary, provide updated policy advice.

Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the potential consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO, 1995), ISPM 5 (FAO, 2019b) and ISPM 11 (FAO, 2019c).

Direct pest effects are considered in the context of the effects on:

- plant life or health

- other aspects of the environment.

Indirect pest effects are considered in the context of the effects on:

- eradication, control
- domestic trade
- international trade
- non-commercial and environmental.

For each of these six criteria, the consequences were estimated over four geographic levels, defined as:

Local—an aggregate of households or enterprises (a rural community, a town or a local government area).

District—a geographically or geopolitically associated collection of aggregates (generally a recognised section of a state or territory, such as 'Far North Queensland').

Regional—a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).

National—Australia wide (Australian mainland states and territories and Tasmania).

For each criterion, the magnitude of the potential consequence at each of these levels was described using four categories, defined as:

Indiscernible—pest impact unlikely to be noticeable.

Minor significance—expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion's intrinsic value. Effects would generally be reversible.

Significant—expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.

Major significance—expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic 'value' of non-commercial criteria.

The estimates of the magnitude of the potential consequences over the four geographic levels were translated into a qualitative impact score (A-G) using Table 3. For example, a consequence with a magnitude of 'significant' at the 'district' level will have a consequence impact score of D.

Table 3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales

	Geographic scale			
Magnitude	Local	District	Region	Nation
Indiscernible	A	A	A	A
Minor significance	B	C	D	E
Significant	C	D	E	F
Major significance	D	E	F	G

Note: In earlier qualitative PRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating 'indiscernible' at all four levels. This combination might be applicable for some criteria. In this report, the impact scale of A to F has been changed to become B-G and a new lowest category A ('indiscernible' at all four levels) was added. The rules for combining impacts in Table 4 were adjusted accordingly.

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

Table 4 Decision rules for determining the overall consequence rating for each pest

Rule	The impact scores for consequences of direct and indirect criteria	Overall consequence rating
1	Any criterion has an impact of 'G'; or more than one criterion has an impact of 'F'; or a single criterion has an impact of 'F' and each remaining criterion an 'E'.	Extreme
2	A single criterion has an impact of 'F'; or all criteria have an impact of 'E'.	High
3	One or more criteria have an impact of 'E'; or all criteria have an impact of 'D'.	Moderate
4	One or more criteria have an impact of 'D'; or all criteria have an impact of 'C'.	Low
5	One or more criteria have an impact of 'C'; or all criteria have an impact of 'B'.	Very Low
6	One or more but not all criteria have an impact of 'B', and all remaining criteria have an impact of 'A'.	Negligible

Estimation of the unrestricted risk

Once the assessment of the likelihood of entry, establishment and spread and for potential consequences are completed, the unrestricted risk can be determined for each pest or groups of pests. This is determined by using a risk estimation matrix (Table 5) to combine the estimates of the likelihood of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the combination of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (for example, low, moderate, high) but the vertical axis refers to likelihood and the horizontal axis refers to consequences. Accordingly, a 'low' likelihood combined with 'high' consequences, is not the same as a 'high' likelihood combined with 'low' consequences—the matrix is not

symmetrical. For example, the former combination would give an unrestricted risk rating of 'moderate', whereas, the latter would be rated as a 'low' unrestricted risk.

Table 5 Risk estimation matrix

Likelihood of pest entry, establishment and spread	Consequences of pest entry, establishment and spread					
	Negligible	Very low	Low	Moderate	High	Extreme
High	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
Negligible	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

The appropriate level of protection (ALOP) for Australia

The SPS Agreement defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Like many other countries, Australia expresses its ALOP in qualitative terms. The ALOP for Australia, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero. The band of cells in Table 5 marked 'very low risk' represents the upper boundary of the ALOP for Australia.

Stage 3 Pest risk management

Pest risk management describes the process of identifying and implementing phytosanitary measures to manage risks to achieve the ALOP for Australia, while ensuring that any negative effects on trade are minimised.

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the appropriate measures to be used. Where the unrestricted risk estimate does not achieve the ALOP for Australia, risk management measures are required to reduce this risk to a very low level. The guiding principle for risk management is to manage risk to achieve the ALOP for Australia. The effectiveness of any proposed phytosanitary measures (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure the restricted risk for the relevant pest or pests achieves the ALOP for Australia.

ISPM 11 (FAO, 2019c) provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the likelihood of entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments—for example, inspection or testing for freedom from pests, prohibition of parts of the host, a pre-entry or post-entry quarantine system, specified conditions on preparation of the consignment, specified treatment of the consignment, restrictions on end-use, distribution and periods of entry of the commodity
- options preventing or reducing infestation in the crop—for example, treatment of the crop, restriction on the composition of a consignment so it is composed of plants belonging to resistant or less susceptible species, harvesting of plants at a certain age or specified time of the year, production in a certification scheme
- options ensuring that the area, place or site of production or crop is free from the pest—for example, pest-free area, pest-free place of production or pest-free production site
- options for other types of pathways—for example, consider natural spread, measures for human travellers and their baggage, cleaning or disinfestations of contaminated machinery
- options within the importing country—for example, surveillance and eradication programs
- prohibition of commodities—if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the level of biosecurity risk does not achieve the ALOP for Australia.

Glossary

Term or abbreviation	Definition
Appropriate level of protection (ALOP)	The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995).
Appropriate level of protection (ALOP) for Australia	The *Biosecurity Act 2015* defines the appropriate level of protection (or ALOP) for Australia as a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to very low, but not to zero.
Australian territory	Australian territory as referenced in the *Biosecurity Act 2015* refers to Australia, Christmas Island and Cocos (Keeling) Islands.
Biological control agent	A natural enemy, antagonist or competitor, or other organism, used for pest control (FAO 2019b).
Biosecurity	The prevention of the entry, establishment or spread of unwanted pests and infectious disease agents to protect human, animal or plant health or life, and the environment.
Biosecurity measures	The *Biosecurity Act 2015* defines biosecurity measures as measures to manage any of the following: biosecurity risk, the risk of contagion of a listed human disease, the risk of listed human diseases entering, emerging, establishing themselves or spreading in Australian territory, and biosecurity emergencies and human biosecurity emergencies.
Biosecurity import risk analysis (BIRA)	The *Biosecurity Act 2015* defines a BIRA as an evaluation of the level of biosecurity risk associated with particular goods, or a particular class of goods, that may be imported, or proposed to be imported, into Australian territory, including, if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or the class of goods, to a level that achieves the ALOP for Australia. The risk analysis process is regulated under legislation.
Biosecurity risk	The *Biosecurity Act 2015* refers to biosecurity risk as the likelihood of a disease or pest entering, establishing or spreading in Australian territory, and the potential for the disease or pest causing harm to human, animal or plant health, the environment, economic or community activities.
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2019b).
The department	The Australian Government Department of Agriculture, Water and the Environment.
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2019b).
Endemic	Belonging to, native to, or prevalent in a particular geography, area or environment.
Entry (of a pest)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled (FAO 2019b).
Establishment (of a pest)	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2019b).
Fumigation	A method of pest control that completely fills an area with gaseous pesticides to suffocate or poison the pests within.
Genus	A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.
Host	An organism that harbours a parasite, mutual partner, or commensal partner, typically providing nourishment and shelter.

Term or abbreviation	Definition
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO, 2019b).
Infection	The internal 'endophytic' colonisation of a plant, or plant organ, and is generally associated with the development of disease symptoms as the integrity of cells and/or biological processes are disrupted.
Infestation (of a commodity)	Presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection (FAO 2019b).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present or to determine compliance with phytosanitary regulations (FAO 2019b).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2019b).
International Plant Protection Convention (IPPC)	The IPPC is an international plant health agreement, established in 1952, that aims to protect cultivated and wild plants by preventing the introduction and spread of pests. The IPPC provides an international framework for plant protection that includes developing International Standards for Phytosanitary Measures (ISPMs) for safeguarding plant resources.
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on Phytosanitary Measures or the Commission on Phytosanitary Measures, established under the IPPC (FAO 2019b).
Introduction (of a pest)	The entry of a pest resulting in its establishment (FAO 2019b).
Larva	A juvenile form of animal with indirect development, undergoing metamorphosis (for example, insects or amphibians).
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2019b).
Non-regulated risk analysis	Refers to the process for conducting a risk analysis that is not regulated under legislation (Biosecurity import risk analysis guidelines 2016).
Nymph	The immature form of some insect species that undergoes incomplete metamorphosis. It is not to be confused with larva, as its overall form is already that of the adult.
Pathogen	A biological agent that can cause disease to its host.
Pathway	Any means that allows the entry or spread of a pest (FAO 2019b).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2019b).
Pest free area (PFA)	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained (FAO 2019b).
Pest risk analysis (PRA)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (FAO 2019b).
Pest risk assessment (for quarantine pests)	Evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences (FAO 2019b).
Pest risk assessment (for regulated non-quarantine pests)	Evaluation of the probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact (FAO 2019b).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2019b).
Pest risk management (for regulated non-quarantine pests)	Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants (FAO 2019b).

Term or abbreviation	Definition
Pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information (FAO 2019b).
Phytosanitary certificate	An official paper document or its official electronic equivalent, consistent with the model of certificates of the IPPC, attesting that a consignment meets phytosanitary import requirements (FAO 2019b).
Phytosanitary certification	Use of phytosanitary procedures leading to the issue of a phytosanitary certificate (FAO 2019b).
Phytosanitary measure	Phytosanitary relates to the health of plants. Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2019b). In this risk analysis the term 'phytosanitary measure' and 'risk management measure' may be used interchangeably.
Phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests (FAO 2019b).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2019b).
Polyphagous	Feeding on a relatively large number of hosts from different plant family and/or genera.
Practically free	Of a consignment, field or place of production, without pests (or a specific pests) in numbers or quantities in excess of those that can be expected to result from, and be consistent with good cultural and handling practices employed in the production and marketing of the commodity (FAO 2019b).
Pupa	An inactive life stage that only occurs in insects that undergo complete metamorphosis, for example butterflies and moths (Lepidoptera), beetles (Coleoptera) and bees, wasps and ants (Hymenoptera).
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing or treatment (FAO 2019b).
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (FAO 2019b).
Regulated article	Any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved (FAO 2019b).
Regulated non-quarantine pest	A non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party (FAO 2019b).
Regulated pest	A quarantine pest or a regulated non-quarantine pest (FAO 2019b).
Restricted risk	Restricted risk is the risk estimate when risk management measures are applied.
Risk analysis	Refers to the technical or scientific process for assessing the level of biosecurity risk associated with the goods, or the class of goods, and if necessary, the identification of conditions that must be met to manage the level of biosecurity risk associated with the goods, or class of goods to a level that achieves the ALOP for Australia.
Risk management measure	Are conditions that must be met to manage the level of biosecurity risk associated with the goods or the class of goods, to a level that achieves the ALOP for Australia. In this risk analysis, the term 'risk management measure' and 'phytosanitary measure' may be used interchangeably.

Term or abbreviation	Definition
Saprophyte	An organism deriving its nourishment from dead organic matter.
Spread (of a pest)	Expansion of the geographical distribution of a pest within an area (FAO 2019b).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures.
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Surveillance	An official process which collects and records data on pest occurrence or absence by surveying, monitoring or other procedures (FAO 2019b).
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests.
Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalisation (FAO 2019b).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk management measures.
Vector	An organism that does not cause disease itself, but which causes infection by conveying pathogens from one host to another.
Viable	Alive, able to germinate or capable of growth.

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