

Indicator protocol: Extent, density and distribution of weeds

Matter for target:

Ecologically significant invasive species

Indicator heading:

Selected ecologically significant invasive vegetation species extent and impact

Indicator name:

Extent, density and distribution of weeds

This document presents the recommended monitoring protocol for collecting, collating and reporting information on the extent, distribution and abundance of significant invasive vegetation species (weeds) for national, state/territory and regional application.

1. Definitions

Extent: Broad-scale distribution of weeds

Occurrence: Relates to the ‘presence’ of a particular species within an area — whether it is present, absent or if there is no data available (ie status unknown, area unassessed). When additional information is available, presence can be described further in terms of distribution and abundance — see below. Occurrence information based on presence/absence is used to determine the extent of a weed.

Distribution: Relates to the spatial pattern of species over an area. Classified as widespread or localised within a given area.

Abundance: Relates to the number or population of a species. In a quantitative situation it might be a count (eg 100) or range (eg 100–150) whereas in a qualitative situation it might be abundant, common or occasional.

Density: Is a measure of abundance per unit area. In a quantitative situation it might be 100/sq km or 100–150/sq km. In a qualitative situation, and for the purposes of reporting state/territory and national data in map format, it could be represented as a combination of abundance and distribution (eg occasional and localised).

Trend: Defined as the change in distribution/abundance over time. Classified as increasing, decreasing, stable or unknown. For the purposes of current mapping work, trend is assessed as increasing/decreasing or stable over the last five (5) years.

2. Rationale

2.1 Why monitor?

Weeds have a major effect on Australia’s natural ecosystems and biodiversity, as well as on cropping, pastoral and forestry production, community health and safety, amenity, infrastructure, tourism, economic well-being and quality of life. Weed research and control are expensive, and often compete with other land management activities for scarce resources.

Uniform monitoring activities across Australia and consistent, reliable reporting processes are essential for effectively controlling weeds. This will make it easier for stakeholders to assess how weed species are responding to management interventions by all involved. To be useful, monitoring requires data collections and information products that yield information on the effectiveness of weed programs (eg rate of change, causes of change in distribution and abundance). It should address management priorities and be designed to minimise the cost of weed control.

Given resource constraints, it is not likely (nor justifiable) to undertake long-term, high-level, detailed monitoring of all species across all jurisdictions. Monitoring should be tailored to provide information on trends in impact, extent, distribution and abundance at scales deemed appropriate for local, regional and national requirements. See also *Indicator Protocol: Impacts of Weeds on Assets*.

In the design of monitoring programs, it is critical to establish a set of agreed monitoring objectives and identify what information/data is required to satisfy both management issues and priorities. This protocol addresses the key issues in quantifying the weed problem:

- Where are significant weeds throughout Australia?
- What is the current level of distribution and abundance of significant weeds throughout Australia?

In particular, this protocol addresses information on the extent, distribution, abundance and trend of weeds to provide:

- broadscale baseline data and information on the extent, distribution, abundance and trend of priority weeds throughout Australia. This data will help assess the success of management interventions based on spatial and temporal changes in weed populations and enables management authorities to make decisions on future management.
- information on the distribution and extent of new and emerging species, allowing resources to be directed to where they may be most effective.

Consistency in the collation of such information over time can provide a broadscale assessment of spatial and temporal trends for well-established and newly establishing species (including new incursions or emerging species) which can be uniformly reported across jurisdictions. Broadscale monitoring of species distribution and abundance is relatively cost-effective, in contrast to detailed monitoring or monitoring of the impact of species over large areas.

Occurrence

Information on occurrence provides an indication of the extent of weed infestations. This helps quantify the scale of management required, determine management options, and detect expansion or contraction in the spatial and temporal range of weed species.

Distribution

Information on species distribution provides an account of the area (and spatial pattern) inhabited by a species.

Abundance

Information on species abundance provides an account of the size of populations for a species. Abundance information is particularly important for species whose extent may not change much in response to management interventions, but where numbers vary and are a measurable and meaningful indicator of management effectiveness. In the absence of quantitative measures, qualitative measures, such as abundant, common or occasional, can be used across large areas. Qualitative measures must be treated cautiously as they are open to observer interpretation and so the values not always comparable between areas or over time.

Density (based on distribution and abundance)

Together, information on distribution and abundance of weeds can be used as a surrogate measure for density (in the absence of more quantitative data) for mapping purposes. Such information can underpin various management activities, such as establishing the scale of management required for any onground control measures, identifying priority areas for control, determining the appropriateness and feasibility of various management options, and assessing any control actions (success) undertaken. Such information can also support improved modelling and reporting procedures such as those required under the National Monitoring and Evaluation Framework.

For most weed species in Australia, there are no programs for the ongoing assessment of the relationship between density and impact. However, within each jurisdiction and nationally there has been considerable work based on known distribution and modelling of potential distribution as part of extensive weed risk assessment programs (the development of frameworks for specific assessments such as economic impact, environmental impact, etc). To improve the understanding of how damage (or impact) changes with changes in density it is important that information is collected on impacts where feasible — see *Indicator Protocols: Impacts of Weeds on Assets*.

3. Monitoring methodology

3.1 Monitoring location selection (scale)

State-wide monitoring/surveys of generalised extent, distribution, abundance and trend information

To develop a consistent view within state/territory jurisdictions on the distribution and abundance of weeds, there must be a way to combine up-to-date datasets of particular species across jurisdictional boundaries. This requires a high degree of standardisation in identification, methods for capturing, recording, storing and collating data and information on location, area, cover/density/abundance, distribution and management actions. This will ensure compatibility and facilitate the transfer of data across programs and between regions and jurisdictions.

For the purposes of generating state-wide monitoring and reporting throughout Australia, a modification of the Queensland State-wide Annual Pest Distribution Survey System has been adopted for implementation in 2006 (see Appendix 1). This system can report data at various scales (eg 25,000, 50,000 and 100,000) based on a nested system using mapsheet tiles. Additional rules have been developed to enable the aggregation of data within a nested environment (eg from 25,000 to 50,000 and 100,000).

Note: A nationally agreed minimum scale of 0.5 degree reporting units has been selected by the Australian Weeds Committee. Additional information at finer resolution scale (eg 25,000 and 50,000) should be collected where feasible, especially as it relates to areas of more intensive land use or interest.

Regional and local scale monitoring of distribution and abundance

A series of nationally agreed approaches for the collection of information on weed distribution and abundance type at regional and local scales already exist. Two examples are listed below:

- The Cooperative Research Centre for Australian Weed Management's *Introductory Weed Management Manual* provides guidelines for landholders, catchment management groups and others involved at a local scale to map weeds and develop local weed management plans.
- The Bureau of Rural Sciences' *A Field Manual for Surveying and Mapping Nationally Significant Weeds* (McNaught et al 2006) is aimed at land managers, land management agencies and research organisations, and is based on collecting a set of core attributes agreed by the Australian Weed Committee for monitoring the distribution and spread of weeds of national significance (WONS). This manual (the WONS field manual) explains in detail the data collection and quality assurance procedures necessary to obtain information in a

systematic way.

Adherence to these guidelines will ensure that data collected are precise, comparable and repeatable, therefore enabling managers and policy makers to develop objective conclusions about weed distribution and trends over time. Guidelines are available for converting data collected according to differing scales and classes (see Appendix 2).

3.2 Monitoring frequency required

The most appropriate frequency and intensity for monitoring the distribution and abundance of weeds varies between species and scale. In addition, external factors such as extreme environmental/climatic or disturbance events (eg abnormally high rainfall or fire), also need to be taken into account when determining monitoring/survey frequency. For example, for a weed that spreads widely and rapidly, it may be required to determine known occurrences and assessment of abundance and distribution, before the weed produces seeds or propagates. In this scenario, an assessment method that can be applied frequently and that locates small infestations needs to be adopted. Less frequent and less precise methods can be applied to assess woody weeds that spread relatively slowly. Annual weeds will need to be assessed during their peak season peak above-ground abundance.

Considerable information is available to help determine monitoring type and frequency, from generalised best-practice guidelines (eg those in the WONS field manual) through to specific guidelines for individual species (eg those developed by the CRC for Weed Management).

Note: The WONS Field Guide outlines recommended guidelines for monitoring including the nature of attributes relevant for various scales.

As a guideline, state/territory-level monitoring to identify trends in abundance, distribution and extent should be coordinated at a minimum frequency of:

- annually at a detailed scale (ie finer than 25,000) for new incursions
- every 2-3 years for emergent species; and
- every 4-5 years for established species.¹

Regional- and local-scale monitoring should occur as frequently as deemed necessary to meet priorities.

3.3 Data measurement method

As with monitoring frequency, considerable information on a range of measurement techniques is available, the actual method chosen being influenced by user needs and scale. For the purposes of national and regional monitoring and surveying activities the WONS field manual differentiates between two types of monitoring: surveillance monitoring (described as monitoring at regional, state and national scales); and investigative monitoring (described as monitoring at the onground, project or local scale). In addition, many jurisdictions already have established methods for data management (eg Weed Watcher in Western Australia, PestInfo in Queensland and 'aerial survey' programs in the Northern Territory), while specific guidelines have been developed for certain species (eg the WONS field manual). As a general guideline, wherever possible, emphasis should be placed on obtaining quantified data and information, supported by qualitative information where quantified data are lacking.

State-level monitoring/surveys to support Invasive Species Indicator requirements

The recommended methods for developing state/territory-level datasets on extent, distribution,

¹ It is anticipated that more specific information on monitoring frequency will become available with the continuing development of various frameworks (eg Framework for Assessing the Environmental Impact of Weeds), and identification of various information products — see Section 4.

abundance and trend are outlined in Appendix 1 (based on the Queensland Department of Natural Resources and Water's Annual Pest Distribution Survey). This method is based on capturing expert knowledge and classifying weeds according to occurrence, distribution and abundance. Information and data from regional or local investigative and surveillance-level surveys should be incorporated into the development of state/territory datasets wherever possible, to maximise the quality of assessments.

Regional and local monitoring/surveys

The WONS field manual and the CRC for Australian Weed Management's *Introductory Weed Management Manual*, plus material developed for specific WONS species, provide additional detail on surveying, collating, assessing data and developing information products suitable for regional and local monitoring activities. In addition, a number of regional natural resource management/catchment groups have developed specific guidelines to assess the extent, distribution, abundance and trend of weeds at the regional and local level.

Species selection

The process of species selection can be complex and is largely determined by national, state/territory, regional and local priorities. There are a number of rating systems available to guide the process of species selection, including:

- those developed for determining weeds of national significance (based on invasiveness and impacts criteria, potential for spread, socioeconomic, and environmental values)
- the Weed Categorisation for Natural and Agricultural Ecosystem Management method developed by Groves et al 2003
- various methods developed at national and state/territory level as part of weed risk assessment activities (eg see the National Post-Border Weed Risk Management Protocol², developed by Standards Australia, Standards New Zealand and the Cooperative Research Centre for Australian Weed Management).

A number of significant frameworks and methods also exist for prioritising weeds (eg Groves et al 2003).

For the purpose of reporting the extent, distribution, abundance and trend at a national scale — as part of the National Monitoring and Evaluation Framework — it has been determined that there should be a list of 98 species, comprising the WONS, the list of weeds nominated for assessment as a WONS (ie the WONS candidate list), the National Environmental Alert list and the Agricultural Sleeper list. Clearly not all species occur in every jurisdiction and each species varies in regional significance with respect to investment under the National Heritage Trust.

Note: The system being promoted to facilitate the development of a nationally consistent database is able to accommodate additional species as they become nationally significant or should they be deemed regionally significant and require assessment. A list of species and their respective source list is given in Appendix 3.

Note: for the purposes of data presentation and the development of information products, in most cases, weeds are mapped at the species level. However, in some cases a finer level of taxon may be more appropriate. For example, in the case of *Chrysanthemoides* the distribution and abundance should be recorded for both subspecies (boneseed and bitou bush) separately as they occur in

² The National Post-Border Weed Risk Management Protocol has been developed to foster the use and further development of decision support systems for prioritising weed species for management at regional, state/territory and national levels. It is based on current best practice in weed management science in combination with the principles of the two Australian/New Zealand Standards: AS/NZS 4360:2004, Risk Management, and HB 203:2006, Environmental Risk Management – Principle and Process. See <http://www.standards.com.au/PDFTemp/Previews/OSH/as/misc/handbook/HB294-2006.pdf>

different habitats and have different control requirements. In addition, some WONS are not individual species but groups of species. For example, in the case of ‘willows’, all species are included except Weeping Willows, Pussy Willow and Sterile Pussy Willow.

3.4 Data collation/calculation method

Regional and local, state/territory and Australian governments should provide the infrastructure for data collation, depending on what is required.

Most jurisdictions collect information on the distribution and abundance of weeds in varying forms and scales. Some jurisdictions collect quantitative point, line and polygon information, while others have datasets based on qualitative information. In most cases, such data needs to be modified or reclassified to meet requirements for national reporting.

Data aggregation guidelines have been developed by NLWRA in cooperation with the CRC for Spatial Information for the representation of point, line and polygon information within a tiled (grid) environment and for the aggregation or generalisation of data within a nested grid environment. Data will be simplified for representation at a reduced (coarser) scale while maintaining its thematic characteristics and integrity for reporting at a national scale.

3.5 Data storage and management

Responsibilities for storing and managing data and information collected, collated and reported by regional groups should be negotiated with the relevant regional and/or state/territory authorities. In principle, however, data should be maintained and be readily accessible for state and national reporting, and stored and managed in accordance with nationally agreed policies and guidelines established by the Australia and New Zealand Information Council (ANZLIC) – the Spatial Information Council. Relevant authorities at state/territory level should be the custodians of their specific datasets.

3.6 Data analysis, integration and interpretation

Data should be analysed and interpreted by regional, local, state/territory or Australian governments, depending on specific needs. Spatial and temporal trends should be ascertained from datasets over time. Final interpretation of state/territory and national level datasets should involve relevant state/territory and national authorities.

3.7 Reliability, validity and quality assurance

Caution is required when interpreting non-validated information from secondary or descriptive processes. Within the method outlined in Appendix 1, it is assumed that the probability of locating weeds will be greater in areas assessed as ‘widespread and abundant’ than in areas classified as occasional and localised.

Results of analysis should be disseminated within the public domain via existing mechanisms (eg the Natural Resource Atlas, http://audit.ea.gov.au/ANRA/atlas_home.cfm), drawing attention to fitness for purpose statements in accompanying metadata documentation.

It is recommended that information is recorded about the quality of the underlying data source/knowledge base used to develop datasets and information products that report the extent, and distribution, of weeds using the methodology outlined in Appendix 1. In relation to the method outlined in Appendix 1, the following five-point grading system/classification is recommended:

- Class 0 — No data.
- Class 1 — Anecdotal information from ad-hoc sources and incidental reports. No reliable expert knowledge or survey data available.
- Class 2 — Expert opinion from experts and local specialists providing a general knowledge based on observations and other sources (eg control activities).

- Class 3 — Some data available plus some extrapolation or expert opinion.
- Class 4 — Scientific data from recognised field sampling surveys (eg WONS field manual or the CRC for Weed Management's *Introductory Weed Management Manual*), systematic sampling and formal assessment, or information based on a high level of expert knowledge. In addition, weeds should be supported by herbarium specimens lodged in the relevant state/territory herbaria.

Note: Within the above system it might be that a combination of, or all categories apply to a given area of interest (eg a 0.5 degree tile).

Other quality assurance statements may be developed via the use of checklists/scorecards and compliance systems based on standards established for the Australian Spatial Data Infrastructure. See for example Module 4 of the Natural Resource Information Management Toolkit: <http://www.nlwra.gov.au/archive/toolkit/4/4-3.html>

For additional information on data quality standards refer to:

http://www.nlwra.gov.au/archive/full/35_data/41_data_protocols/data_protocols.html

In addition to the above, it is important that there is some form of evaluation or review of monitoring activities (including the methods proposed within this protocol), to help refine and improve monitoring programs.

3.8 Metadata

It is a basic prerequisite that metadata documentation is completed for all datasets. Such statements should be consistent with ANZLIC standards <http://www.anzlic.org.au/policies.html> (click Metadata protocol and standard metadata profile [PDF: 99pp, 705kb]).

Note ANZLIC is working towards the international ISO 19115 standard http://www.osdm.gov.au/osdm/docs/resources/mwg_aus_gov_profile.pdf

4. Reporting/information products

4.1 Audiences

Natural resource managers at all levels are demanding consistency between related datasets and standardised descriptions of similar features, so that features are defined or classified the same way across Australia.

Information on extent, distribution and abundance, and trends in these attributes, benefit multiple users at different scales. Local and regional information products support decision makers in designing and evaluating control programs, NRM regional planning, and the development of regional investment strategies. State/territory information products provide decision makers and managers with resource condition and trend information necessary to allocate resources for control, disease surveillance, contingency planning, plus informing policy, and developing and implementing legislation. National and state/territory information is also useful for plant health and biosecurity authorities, and reporting the magnitude of weeds problems at a national level for industry, research organisations, regulatory authorities and quarantine services. In addition, information products support a range of other uses including education and improving general awareness and engagement of the broader community, water management authorities, etc.

4.2 Products

Various information products can be developed on datasets at differing scales (local, regional, state/territory and national) providing information on weed extent, distribution, abundance and trend. Maps, summary reports and statistics can be developed to gauge the effectiveness of management over time and track progress in resource condition and trend. Products may include descriptive maps (at regional, state/territory, and national levels) with corresponding summary details on the area inhabited by weeds, and different distribution and abundance categories.

At state/territory and national levels, information on extent, distribution, abundance and trend should be reported according to the method outlined in Appendix 1. In summary this involves:

- occurrence: present, absent or unknown
- distribution: localised or widespread
- abundance: abundant, common or occasional
- trend: increasing, decreasing, stable, unknown

Additional products can be generated based on a number of boundaries such as natural resource management regions, river basins, Interim Biogeographic Regionalisation for Australia regions, or the estuarine, coastal and marine area around the coast of Australia.

4.3 Confidentiality

Maintaining confidentiality of data will be the responsibility of the custodian of the data (eg the relevant management authority at state/territory level responsible for monitoring and reporting weed information). Aggregation of data to the national format (0.5 degree grid tile) is not considered likely to affect confidentiality of state-administered datasets.

4.4 Data collation/calculation method

The development of national datasets and information products for publishing (eg statistics, graphs and maps) showing extent, distribution, abundance, data quality and trends will require transformation of state/territory datasets (which are sometime point-based) for representation within a tiled mapsheet environment. In some cases it will require the aggregation/generalisation of data a fine scales (eg 25,000) for representation at 100,000 within a nested environment. Data aggregation guidelines have been developed to facilitate this process.

4.5 Data analysis, integration and interpretation information

It is not envisaged that any detailed analytical or conceptual modelling activities will be required to process datasets on current extent, distribution, abundance and trend, and the subsequent development of various information products. However, as indicated above, the development of recommended guidelines for the representation of point, line and polygon data within a tiled environment and for aggregation between fine (eg 25,000) and coarse (eg 100,000) scales are currently being developed.

Development of national products based on a collation of state/territory datasets will require consultation with relevant state/territory-based authorities to address issues of cross-border differences and other issues, in order to develop a uniform and seamless dataset.

Modelling tools are available to determine potential national distribution and abundance (based on classes of likelihood). See the Indicator on potential maximum extent.

4.6 Data access and storage

It is important that national level information can be updated via links to relevant regional and state/territory database/information systems. It is proposed that national information is reported through the National Land and Water Resources Atlas and Data Library, and in the future the Australian Resources Online. It will be the responsibility of the Australian Government to host these services.

Data access arrangements need to be developed with various stakeholders and may influence data confidentiality (see Section 4.3).

4.7 Product definition statement

Each product should have a product definition statement. The product definition statement should follow the same general format as the metadata statement in Appendix 4.

5. Current national activities

Appropriate data infrastructure and a reporting framework at all levels (local and regional, state and territory, and national) will be required for reporting extent and distribution data.

6. Future development

Inclusion of procedures (as developed and available) for aggregating state/territory level data from a range of scales to the national format (0.5 degree grid cell) will be required.

Note: recommendations for aggregation processes are currently being addressed in cooperation with the CRC for Spatial Information and, when available, will be incorporated within this protocol document. Refinement of the national priority species lists and inclusion of additional species will be required based on fluctuating state/territory and national priorities.

7. Links to other indicators

Other indicators relevant to extent, density and distribution of weeds are:

- selected ecologically significant invasive vertebrate species extent and impact
<http://www.nrm.gov.au/monitoring/indicators/vertebrate.html>
- selected significant native species and ecological communities extent and conservation status
<http://www.nrm.gov.au/monitoring/indicators/signif-species.html>
- estuarine, coastal and marine habitat extent and distribution: pest species (number, density, distribution)
<http://www.nrm.gov.au/monitoring/indicators/estuarine/pest-species.html>.

8. Further information

Specific references:

Campbell MH (1977). Assessing the area and distribution of serrated tussock, St John's wort and sifton bush in New South Wales. Technical Bulletin No. 18, Department of Agriculture New South Wales.

CRC for Australian Weed Management (2004). *Introductory Weed Management Manual*, Cooperative Research Centre for Australian Weed Management, Adelaide.

Gerrand D (2003). *Hastings Council Bitou Bush Control Strategy* (draft), Hastings Council, Coastcare, New South Wales National Parks and Wildlife Service, Department of Land and Water Conservation and NSW Agriculture.

Groves RH, Hoskings JR, Batianoff GN, Cooke DA, Cowie ID, Johnson RW, Keighery GJ, Lepschi BJ, Mitchell AA, Moerkerk M, Randall RP, Rozefelds AC, Walsh NG and Waterhouse BM (2003). *Weed Categories for Natural and Agricultural Ecosystem Management*, Bureau of Rural Sciences, Canberra.

McNaught I, Thackway M, Brown L and Parsons M (2006). *A Field Manual for Surveying and Mapping Nationally Significant Weeds*. Bureau of Rural Sciences, Canberra.

Standards Australia/Standards New Zealand/Cooperative Research Centre for Australian Weed Management (2006) Handbook 294:2006 National Post-Border Weed Risk Management Protocol.

Thackway R, Yapp G, Cunningham D and McNaught I (2003). Towards a national set of core attributes for mapping Weeds of National Significance (WONS), discussion paper September

2003, Bureau of Rural Sciences, Canberra.

Thorp JR and Lynch R (2000). *The Determination of Weeds of National Significance*, National Weeds Strategy Executive Committee, Launceston.

Websites:

- Australian Government Department of Agriculture, Fisheries and Forestry
<http://www.daff.gov.au>
- Australian Government Department of the Environment and Water Resources
<http://www.environment.gov.au>
- Australian Capital Territory — Environment ACT
<http://www.environment.act.gov.au>
- CRC for Australian Weeds Management
<http://www.weeds.crc.org.au/>
- New South Wales — Department of Primary Industries
<http://www.dpi.nsw.gov.au>
- Northern Territory — Department of Natural Resources, Environment and the Arts
<http://www.nt.gov.au/nreta>
- Queensland — Department of Natural Resources and Water
<http://www.nrw.qld.gov.au>
- South Australia — Department of Water, Land and Biodiversity Conservation
<http://www.dwlbc.sa.gov.au>
- Tasmania — Department of Primary Industries and Water
<http://www.dpiw.tas.gov.au>
- Victoria — Department of Sustainability and Environment
<http://www.dse.vic.gov.au>
- Weeds Australia
<http://www.weeds.org.au>
- Western Australia — Department of Agriculture and Food
<http://www.agric.wa.gov.au>

9. Glossary

Abundance: Relates to the number or population of species. In a quantitative situation it might be a count (eg 100) or range (eg 100–150) whereas in a qualitative situation it might be abundant, common or occasional.

Cover: The percentage of cover a weed occupies over the ground or canopy – see Appendixes 3–5 in WONS Field Manual (McNaught et al 2006) for more information.

Density: Is a measure of abundance per unit area. In a quantitative situation it might be 100/sq km or 100–150/sq km. In a qualitative situation, and for the purposes of reporting state/territory and national data in map format, it could be represented as a combination of abundance and distribution (eg occasional and localised).

Distribution: Relates to the spatial pattern of species over an area (eg widespread or localised within a given area).

Emerging species: A newly established weed species whose extent, distribution and abundance is expanding (ie trend is increasing), and whose impacts are likely to be significant.

Extent: Broad-scale distribution of weeds

Investigative monitoring: Monitoring at the onground, project or local scale. Normally results in point, line or polygon data

New incursions: Defined as any introduced (non-endemic) weed species that has not been recorded previously at a location and whose impacts are likely to be significant

Occurrence: Relates to the 'presence' of a particular species within an area — whether it is present, absent or no data available (ie status is unknown, area un-assessed). When additional information is available the presence class of occurrence can be described further in terms of distribution and abundance — see above. Occurrence information based on presence/absence is used to determine the extent of a weed.

Significant: Defined by state/territory and national declarations and recommendations from relevant national authorities

Surveillance monitoring: Monitoring at regional, state or national level. May be vector (point, line or polygon) or grid/tiled information.

Trend: Defined as the change in distribution/abundance over time. Classified as increasing, decreasing, stable or unknown. For the purposes of current mapping work, trend is assessed as increasing/decreasing or stable over the last five (5) years.

10. Appendices

10.1. Appendix I: State/territory wide Weed Extent, Distribution and Abundance Survey Methodology

Note: modified from Queensland Government Annual Pest Distribution Survey — see http://www.nrw.qld.gov.au/pests/maps/pest_distribution/annual_pest_dist_maps.html

Occurrence, distribution, abundance and trend classifications

Step 1 Species occurrence — present/absent/unknown

The occurrence of a pest can be recorded as:

- present: species exists in the cell
- absent: species does not exist in the cell
- unknown: status is not known (no data is available, area is un-assessed).

This criterion has the highest level of accuracy.

Step 2 Distribution — localised/widespread

When presence is confirmed, the distribution of the species (incursion or spread of a species) within that cell can be recorded as:

- widespread: species occurs in most areas and occupies greater than 50% of a cell
- localised: species occurs in a clumped pattern and occupies less than 50% of a cell.

While distribution provides a useful indication of the size of infestations, its accuracy is influenced by survey participants varying perceptions of populations and because there is difficulty in assessing large areas of land. This criterion has a lower level of accuracy than 'occurrence'.

Step 3 Abundance — low or occasional/medium or common/high or abundant

Abundance refers to the number of a species within an area and can be described as:

- occasional: single weeds spaced at wide intervals (eg rare observations/evidence)
- common: a middle measure between low/occasional and high/abundant (eg frequent observations/evidence)
- abundant: infestations that have reached their full potential (giving consideration to existing soil types and land use etc) and provide little opportunity for additional plants to survive in that area (eg regular observations/evidence).

Abundance is particularly difficult to estimate because participants' perception of abundance levels vary with species; species detection varies between habitat types; and some habitats support higher concentrations of species that depend on environmental conditions or carrying capacity.

This criterion has a lower level of accuracy than 'distribution'. Abundance can be considered more accurate at the local/regional level than at the state level.

Step 4 Density — a measure of abundance per unit area, developed for reporting/map publishing purposes

Density is based on the above a combination of distribution and abundance, for example:

- occasional and localised
- occasional and widespread
- common and localised
- common and widespread
- abundant and localised
- abundant and widespread.

Step 5 Trend — a measure of change in abundance and distribution over time. In the absence of a time-series of survey data the classification has been developed to capture anecdotal information

- Increasing: populations have increased over the last 5 years.
- Decreasing: populations have decreased over the last 5 years.
- Stable: populations have remained stable or fluctuations are in line with seasonal conditions and control programs.
- Unknown.

10.2. Appendix 2: Guidelines for conversion of data

Classification ¹	Classification ²	Classification ⁴	Classification ⁵	Classification ⁶
Scattered individual plants	Occasional	Single plants and clumps	Light	Class 3: 1–10%
Scattered patches with isolated plants interspersed	Common	Partially accessible thickets	Medium	Class 4: 11–50%
Large dense infestations	Abundant	Impenetrable thickets	Heavy	Class 5: 51–100%

1. Campbell (1977)

2. Queensland Annual Pest Distribution Survey system

4. Method used for rating lantana infestations

5. Gerrand (2000) Abundance categories of bitou bush

6. WONS Classes

Source: After McNaught et al (2006) (Appendix 4)

10.3. Appendix 3: Significant weed species chosen for a national assessment in 2006

Common name	Scientific name	Source list
African Boxthorn	<i>Lycium ferocissimum</i>	Nominated for assessment as a weed of national significance
African Love Grass	<i>Eragostis curvula</i>	Nominated for assessment as a weed of national significance
Alligator Weed	<i>Alternanthera philoxeroides</i>	Weed of national significance, target for biocontrol
Arum Lilly	<i>Zantedeschia aethiopica</i>	Nominated for assessment as a weed of national significance
Athel Pine	<i>Tamarix aphylla</i>	Weed of national significance
Barleria	<i>Barleria prionitis</i>	National environmental alert list
Bathurst Burr	<i>Xanthium spinosum</i>	Nominated for assessment as a weed of national significance
Bellyache Bush	<i>Jatropha gossypifolia</i>	Nominated for assessment as a weed of national significance, target for biocontrol
Bitou Bush/Boneseed	<i>Chrysanthemoides monilifera</i>	Weed of National significance target for biocontrol
Blackberry	<i>Rubus fruticosus</i> agg.	Weed of national significance, target for biocontrol
Blue Hound's Tongue	<i>Cynoglossum creticum</i>	National environmental alert list
Blue Thunbergia	<i>Thunbergia grandiflora</i>	Nominated for assessment as a weed of national significance
Brazilian Pepper	<i>Schinus terebinthifolia</i>	Nominated for assessment as a weed of national significance
Bridal Creeper	<i>Asparagus asparagoides</i>	Weed of national significance, target for biocontrol
Bridal Veil	<i>Asparagus declinatus</i>	Nominated for assessment as a weed of national significance
Broom Montpellier Or Cape Broom	<i>Genista monspessulana</i>	Nominated for assessment as a weed of national significance, target for

Common name	Scientific name	Source list
		biocontrol
Broomrape (All Spp).	<i>Orobanche</i> spp.	Nominated for assessment as a weed of national significance, Branch Broomrape is a joint funded eradication species
Bulbil Watsonia	<i>Watsonia meriana</i> var. <i>bulbillifera</i>	Nominated for assessment as a weed of national significance
Cabomba	<i>Cabomba caroliniana</i>	Weed of national significance
Calotrope	<i>Calotropis procera</i>	Nominated for assessment as a weed of national significance
Cane Needle Grass	<i>Nassella hyalina</i>	National environmental alert list
Cat's Claw Creeper	<i>Macfadyena unguis-cati</i>	Nominated for assessment as a weed of national significance
Chilean Needle Grass	<i>Nassella neesiana</i>	Weed of national significance
Chinee Apple	<i>Zizyphus mauritiana</i>	Nominated for assessment as a weed of national significance
Chinese Elm	<i>Celtis sinensis</i>	Nominated for assessment as a weed of national significance
Chinese Rain Tree	<i>Koelreuteria elegans</i> subsp. <i>formosana</i>	National environmental alert list
Chinese Violet	<i>Asystasia gangetica</i> subsp. <i>micrantha</i>	National environmental alert list, agricultural sleeper list
Creeping Lantana	<i>Lantana montevidensis</i>	Nominated for assessment as a weed of national significance
Cutch Tree	<i>Acacia catechu</i>	National environmental alert list
Cyperus	<i>Cyperus teneristolon</i>	National environmental alert list
False Yellowhead	<i>Dittrichia viscosa</i>	National environmental alert list
Fireweed	<i>Senecio madagascariensis</i>	Nominated for assessment as a weed of national significance, target for biocontrol

Common name	Scientific name	Source list
Garden Geranium	<i>Pelargonium alchemilloides</i>	National environmental alert list
Giant Parramatta Grass	<i>Sporobolus indicus</i> var <i>major</i>	Nominated for assessment as a weed of national significance
Giant Rat's Tail Grass	<i>Sporobolus natalensis</i> and <i>S. pyramidalis</i>	Nominated for assessment as a weed of national significance
Golden Dodder	<i>Cuscuta campestris</i>	Nominated for assessment as a weed of national significance
Gorse	<i>Ulex europaeus</i>	Weed of national significance
Grader Grass	<i>Themeda quadrivalvis</i>	Nominated for assessment as a weed of national significance
Heather	<i>Calluna vulgaris</i>	National environmental alert list
Holly Leaf Senecio	<i>Senecio glastifolius</i>	National environmental alert list
Honey Locust	<i>Gleditsia triacanthos</i>	Nominated for assessment as a weed of national significance
Horsetails	<i>Equisetum</i> spp.	National environmental alert list
Hydrocotyle	<i>Hydrocotyle ranunculoides</i>	Nominated for assessment as a weed of national significance
Hymenachne	<i>Hymenachne amplexicaulis</i>	Weed of National Significance
Hyptis	<i>Hyptis suaveolens</i>	Nominated for assessment as a weed of national significance
Karoo Thorn	<i>Acacia karroo</i>	National environmental alert list
Kochia	<i>Bassia scoparia</i>	Nominated for assessment as a weed of national significance, national environmental alert list
Lagarosiphon	<i>Lagarosiphon major</i>	National environmental alert list
Lantana	<i>Lantana camara</i>	Weed of national significance, target for biocontrol
Laurel Clock Vine	<i>Thunbergia laurifolia</i>	National environmental alert list

Common name	Scientific name	Source list
Leaf Cactus	<i>Pereskia aculeata</i>	National environmental alert list
Lippia	<i>Phyla canescens</i>	Nominated for assessment as a weed of national significance
Lobed Needle Grass	<i>Nassella charruana</i>	National environmental alert list, agricultural sleeper list
Madeira Vine	<i>Anredera cordifolia</i>	Nominated for assessment as a weed of national significance
Mesquite	<i>Prosopis</i> spp.	Weed of national significance, target for biocontrol
Mexican Poppy	<i>Argemone ochroleuca</i>	Nominated for assessment as a weed of national significance
Mimosa	<i>Mimosa pigra</i>	Weed of national significance, target for biocontrol
Mission Grass	<i>Pennisetum polystachion</i>	Nominated for assessment as a weed of national significance
Mother Of Millions	<i>Bryophyllum tubiflorum</i> and hybrids	Nominated for assessment as a weed of national significance, target for biocontrol
Myrtleleaf Milkwort	<i>Polygala myrtifolia</i>	Nominated for assessment as a weed of national significance
Narrow Leaf Cotton Bush	<i>Gomphocarpus fruticosus</i>	Nominated for assessment as a weed of national significance
Noogoora Burr	<i>Xanthium occidentale</i>	Nominated for assessment as a weed of national significance
Onopordum Thistles	<i>Onopordum</i> spp.	Nominated for assessment as a weed of national significance, 4 species are target for biocontrol
Orange Hawkweed	<i>Hieracium aurantiacum</i>	National environmental alert list, agricultural sleeper list
Pampas Grass	<i>Cortaderia</i> spp.	Nominated for assessment as a weed of national significance
Parkinsonia	<i>Parkinsonia aculeata</i>	Weed of national significance, target for biocontrol
Parthenium Weed	<i>Parthenium hysterophorus</i>	Weed of National significance, target for biocontrol

Common name	Scientific name	Source list
Paterson's Curse	<i>Echium plantagineum</i>	Nominated for assessment as a weed of national significance, target for biocontrol
Pond Apple	<i>Annona glabra</i>	Weed of national significance
Praxelis	Praxelis clematidea	National environmental alert list
Prickly Acacia	<i>Acacia nilotica</i> subsp. <i>indica</i>	Weed of national significance, target for biocontrol
Privet Broad Leaf or Tree Privet	<i>Ligustrum lucidum</i>	Nominated for assessment as a weed of national significance
Privet Small Leaf or Chinese Privet	<i>Ligustrum sinense</i>	Nominated for assessment as a weed of national significance
Ragwort	<i>Senecio jacobaea</i>	Nominated for assessment as a weed of national significance
Rice Grass	<i>Spartina anglica</i>	Nominated for assessment as a weed of national significance
Rosewood	<i>Tipuana tipu</i>	National environmental alert list
Rubber Vine	<i>Cryptostegia grandiflora</i>	Weed of national significance, target for biocontrol
Salvinia	<i>Salvinia molesta</i>	Weed of national significance, target for biocontrol
Scotch Broom	<i>Cytisus scoparius</i>	Nominated for assessment as a weed of national significance
Sea Spurge	<i>Euphorbia paralis</i>	Nominated for assessment as a weed of national significance
Senegal Tea Plant	<i>Gymnocoronis spilanthoides</i>	National environmental alert list
Serrated Tussock	<i>Nassella trichotoma</i>	Weed of national significance, target for biocontrol
Siam Weed	<i>Chromolaena odorata</i>	National environmental alert list, joint funded eradication species
Sicklepod	<i>Senna obtusifolia</i> and <i>S. tora</i>	Nominated for assessment as a Weed of national significance, target for biocontrol

Common name	Scientific name	Source list
Sida Spp.	<i>Sida</i> spp.	Nominated for assessment as a weed of national significance, 3 species target for Biocontrol
Silver Leaf Nightshade	<i>Solanum elaeagnofolium</i>	Nominated for assessment as a weed of national significance, target for biocontrol
Snake Weed	<i>Stachylarpheta</i> spp.	Nominated for assessment as a weed of national significance
Spanish Heath	<i>Erica lusitanica</i>	Nominated for assessment as a weed of national significance
St John's Wort	<i>Hypericum perforatum</i>	Nominated for assessment as a weed of national significance
Subterranean Cape Sedge	<i>Trianoptiles solitaria</i>	National environmental alert list
Tobacco Weed	<i>Elephantopus mollis</i>	Nominated for assessment as a weed of national significance
Uruguayan Rice Grass	<i>Piptochaetium montevidense</i>	National environmental alert list, agricultural sleeper list
Water Hyacinth	<i>Eichornia crassipes</i>	Nominated for assessment as a weed of national significance, target for biocontrol
White Spanish Broom	<i>Cytisus multiflorus</i>	National environmental alert list
White Weeping Broom	<i>Retama raetam</i>	National environmental alert list
Wild Mignonette	<i>Reseda luteola</i>	Nominated for assessment as a weed of national significance, target for biocontrol
Willows (Except Weeping Willows, Pussy Willow And Sterile Pussy Willow)	<i>Salix</i> spp. (except <i>S. babylonica</i> , <i>Salix</i> × <i>calodendron</i> and <i>Salix</i> × <i>reichardtiji</i>)	Weed of national significance

Common name	Scientific name	Source list
Yellow Soldier	<i>Lachenalia reflexa</i>	National environmental alert list

10.4. Appendix 4: Information product template

Information product name		
Product ID or reference number	Jurisdiction, agency or custodian's reference number if applicable.	
URL for product metadata	A webpage reference to where more comprehensive details of the product are recorded.	
Jurisdiction		
Custodian		
Contact details	Relevant person, position, branch/unit/section, location and phone, email contacts.	

Relevant matter for target	Which NM&EF matter for target does this product relate to?	
Relevant national indicator	Which NM&EF indicator(s), if any, does this product relate to?	
Relevant state/territory indicator	Which state/territory indicator(s), if any, does this product relate to?	

Description	Provide a brief description of the product including the purpose and the output file format.	
Source data name and ASDD link	Name all the source dataset(s) used to produce the product. Provide references to metadata for source datasets used. This should be either the ASDD metadata reference or other URL. If any source dataset is not already described to ASDD Page 0 standard, please complete the accompanying template.	
Source data attributes used	Please list the attributes used from each of the source datasets to produce the information product.	
Processing of source data	Please describe the steps taken in processing and combining the source data to produce the information product.	

Status	What is the current status of the product? If the product is 'In progress' or 'Is planned', please complete as many of the remaining descriptors as are known.	a. Currently exists b. In progress c. Is planned
Coverage	How much of the state/territory distribution of the resource (or applicable part of the state/territory) is covered by the product?	a. 80–100% b. 50–80% c. 20–50% d. 0–20%
Recency	When was the dominant contributing data established?	a. 2005–2000 b. 2000–1995 c. 1995–1985 d. 1985–1970 e. 1970–1950 f. <1950
Trend	Does the dataset support trend interpretation?	a. Sequence (eg river flow, rainfall) b. Multiple (few) (eg land use 1990 & 2000) c. Single (eg soil type)
Usability scale	What is the finest resolution that maintains confidence in the product (ie not to be used at 1:100,000 or less).	a. Local b. Regional c. State d. National
Availability	What is the public availability of the product? Is a licence required for outside users?	a. Open b. Restricted/licence c. Closed
Delivery	How is the product best delivered?	a. Web services b. Digital data c. Electronic document d. Paper document
Content type	What type of information does the product represent?	a. Real data b. Mixture of real & modelled data c. Modelled data
Update	What will be the frequency of update for the product?	a. Frequently b. At least once/planned c. Not planned/unknown
Other relevant information	Please add any other important information relevant to this information product that should be known	