The Science Division's Vegetation Health Service – a Review
April 2008

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Summary

A detailed review of the role of the Vegetation Health Service (VHS), the services and other outputs it provides, its staff and facilities is given. A "for" and "against" assessment is provided in considering three possible scenarios for the future operation of the VHS: 1) continuation of the present VHS operations; 2) introduction of charges to Departmental clients for VHS services that are currently free of charge; and 3) closure of the VHS, outsourcing its functions, and reallocating its resources within Science Division. The role and importance of the VHS is discussed in the overall context of Phytophthora Dieback management in Western Australia, and in relation to the Key Strategic Goals of Science Division. A commentary is given on the development of molecular procedures using the polymerase chain reaction (PCR) to detect *Phytophthora cinnamomi* in soil samples as an alternative to the baiting and isolation methods used in the VHS. It is recommended that the VHS should continue to operate within the Science Division's Flora Conservation and Herbarium Program, and to continue providing its services without charge to all DEC clients.

1. Overview

The **Vegetation Health Service (VHS)** is a Core Function of DEC's Science Division, operating under the Flora Conservation and Herbarium Program. The VHS provides a dedicated, **specialist scientific service for the detection and identification of *Phytophthora* species** in samples collected as part of DEC's ongoing Dieback mapping and monitoring program in the State's natural ecosystems, and in research programs.

In addition, the VHS maintains a statewide computer-based **database** of *Phytophthora* distribution (containing over 31,000 records, with details of all samples processed by the VHS from 1982). The VHS initiated and now maintains an expanding live *Phytophthora* **Culture Collection** that is a unique and highly valuable scientific resource available to researchers both within DEC and externally. Cultures in the collection that were isolated by VHS staff date from 1979, and some Phytophthoras isolated in the 1960s are also held.

VHS staff provide **advice** to Departmental staff and the public on plant disease matters. VHS staff also produce **scientific publications** arising directly from the work of the lab.

The VHS forms part of DEC's partnership contribution to the **Centre for *Phytophthora* Science and Management (CPSM)** at Murdoch University, and the VHS Manager jointly supervises relevant **student projects** under this partnership.

The VHS is located in the DEC Science Division's Kensington Research Centre, and is staffed by permanent Science Division personnel.

2. Role of the VHS and Services Provided

The primary role of the VHS is to provide a **specialist scientific service for the detection and identification of *Phytophthora* species** from samples associated with:

- DEC's ongoing management of the State's forest and conservation estate in general;
- Land management associated with logging and mining activities in the DEC Estate;
- Science Division and Student research projects;
- Special projects, such as the Biodiversity Conservation Initiative (BCI); and
- The needs of external clients, eg other Government departments, local government, private industry, environmental consultants, and landholders.

The management of Phytophthora Dieback is an essential element of DEC's land and biodiversity management and nature conservation roles, and there is no question that it will continue to be so in the long term. The VHS underpins this function, providing continuity of a high-quality, integrated, **essential service** that is not available to DEC's land managers and scientists at a comparable level elsewhere. The VHS is geared primarily to service this need for DEC (whereas the very few external operators that can provide such a service will have other, business-driven priorities, and do not have comparable processing capacity).

The VHS has evolved to its present form since its beginnings in the early 1980s at Dwellingup. VHS staff can respond quickly to urgent requests for service or advice, and have well-established, close working relationships with the DEC Dieback Interpreters, Forest Management Branch (FMB), the Dieback Coordinator, Scientists, Regional Ecologists, other DEC Regional and District staff, and Geographic Information Services (GIS) Section.

Phytophthora isolates are identified to species in the VHS laboratory using traditional morphological techniques. Those that cannot be identified to species in this way are sent to the CPSM (Murdoch University) for DNA sequence analysis and species identification.

In 2006-2007 a total of 1,696 samples were processed by the VHS; full details of the results and the services provided are given in the VHS Annual Report (Stukely *et al*., 2007a).

3. Operational Basis

The VHS is funded by DEC's Sustainable Forest Management Division (90%) and Nature Conservation Division (10%). The VHS laboratory is run by permanent Science Division staff based at DEC's Kensington Research Centre. **Its services are offered free of charge to all DEC sections and personnel.** The service is also available to external clients at a standard fee of $77 (incl. GST) per sample, with special discounted rates applying to Alcoa World Alumina Australia and to Natural Heritage Trust projects. The small number of samples received from the Forest Products Commission continue to be processed free.

An annual operating budget of $5,000 is allocated to the VHS by Science Division, and this has been unchanged since the present (then new) laboratory was established at Kensington in 1992 (and prior to that, when the sample baiting was carried out at Dwellingup Research Centre, this budget had been unchanged since 1984). To cover the increasing cost of basic consumables, equipment and scheduled maintenance, this very basic DEC funding is supplemented by the revenue received by the VHS each year for processing samples for paying (external) clients. This revenue also covers essential major equipment repairs, maintenance and purchases; library purchases (books and journal subscriptions); travel and vehicle running expenses; occasional publications; and also contributions to the funding of Student projects being jointly supervised through CPSM (currently one PhD project at Murdoch University is receiving funds from the VHS, at $5,000 per annum).

VHS facilities are also made available for the use of Scientists and Students. They may carry out their own sample processing in the VHS if desired, with cost recovery by the VHS for consumables only. The necessary instruction and guidance is given by VHS staff. In addition, equipment available only in the VHS, such as the three large autoclaves, is used regularly by all Kensington-based (and some other) DEC scientists working in plant pathology.

4. Staff

The VHS is managed by a Research Scientist, Mike Stukely (0.35 FTE, Level 5), and Technical support (1 FTE) is provided on a permanent time-share basis by two Technical Officers, Janet Webster (0.6 FTE, Level 3) and Juanita Ciampini (0.4 FTE, Level 2). J Ciampini has been funded by the *Saving Our Species* Phytophthora Dieback control project to work one extra day per week in 2006-2007 and 2007-2008.

The three VHS staff members have a combined total of over 58 years' experience in *Phytophthora* isolation and identification, working for DEC and its predecessors.

5. Facilities

The VHS, located in its own separate building at Kensington Research Centre, consists of:

- **Main VHS laboratory,** where *Phytophthora* identifications are carried out using high-power optical microscopes and a customised, computer-based digital imaging system; other 'clean' bench work is carried out; the live Culture Collection is maintained in a bank of incubators; and paper records are stored. This room also includes office facilities and computers for the technical staff;
- **Smaller adjoining "clean" lab,** with laminar flow ("clean air") cabinet for sterile culturing, an autoclave for preparation of sterile culture media and apparatus, a weighing bench, a refrigerator and incubator, and a still for distilled water production;
- **Two constant-temperature incubation rooms,** where samples are held during the baiting process, baits are transferred to agar plates and incubated for *Phytophthora* isolation, and where the *Eucalyptus sieberi* cotyledon baits are produced from seed;
- **"Dirty" lab,** where the processing of samples starts with setting up the bait dishes;
- **"Dirty" autoclave area,** on the veranda, where all processed sample material and old culture plates are steam-sterilised before disposal;
- **An additional constant-temperature incubation room**, located in the south wing of the main Research Centre building (Room #7), where part of the VHS Culture Collection is kept.

6. Future Options Considered

Points 'for' and 'against' three possible scenarios for the future operation of the VHS (or its closure with outsourcing) are listed below.

6.1 Scenario 1: Continue present VHS operations (*status quo*)

For	Against
1. Continuity of the VHS's specialist, scientific service, under Science Division's control. The service continues to be based on sound science, and the necessary standards are maintained. 2. The capacity of the VHS continues to meet the needs of routine operational sample processing for DEC and paying (external) clients, as well as Special Projects sometimes at short notice. 3. The very substantial experience and specialist expertise of the VHS staff is retained in this critical role. 4. DEC is ***seen*** to be supporting its leading role in Dieback Management in WA as a high priority, by operating the VHS through its Science Division. 5. The VHS is geared primarily to meet the needs of DEC land managers and scientists (as opposed to serving other business objectives as a commercial enterprise), and continues to build on these very effective working relationships. 6. Costs to DEC managers and scientists are minimal, as the services of VHS are provided **free of charge to all DEC sections**. [External service-providers now charge from ~$85 to well over $100 per sample, at 2006 rates]. Example: approx. 1,180 samples have been processed by the VHS for the BCI *Phytophthora* project since mid-2006, at no charge. The cost of processing this number of samples externally would be prohibitive. 7. The free service available to DEC sections provides them with a strong incentive to take adequate numbers of samples for testing, and also to re-test key sites regularly, rather than taking minimal numbers of samples due to the cost. This enhances the quality and accuracy of the mapping of Phytophthora Dieback, and hence its management. 8. The VHS's unique state *Phytophthora* database continues to be expanded, covering all clients' samples, and enabling *Phytophthora* species distribution maps to be drawn using data from all possible sampling sources. 9. The VHS's state *Phytophthora* Culture Collection continues to be added to, and maintained, in-house, with all associated benefits and controls. This exceptional scientific resource is unique. 10. Science Division's contribution to the CPSM, and our strong working relationship there, continues through the VHS and to our mutual benefit. 11. Supervision of relevant Student projects by the VHS Manager, and practical and funding assistance to students by the VHS, continues. 12. Collaborative scientific projects continue, and joint publications by VHS and CPSM authors continue to be produced. 13. Equipment and facilities of the VHS continue to be available for use by other DEC scientists, as well as students. 14. Revenue flow to Science Division from VHS "private" (external) clients continues. As well as covering VHS operating needs, this revenue provides funds for library purchases and journal subscriptions, assistance for Student projects, and for staff travel and attendance at conferences etc. 15. The already strong reputation of the VHS continues to be enhanced, in both the land management and broader scientific communities.	1. Salary and resources of VHS are not available for reallocation.

6.2 Scenario 2: Continue present VHS operations, but charge all DEC clients for VHS services (that are now provided free)

For (additional to Scenario 1)	Against
1. Revenue for DEC samples (all formerly processed free of charge) flows to Science Division, through the VHS.	1. Negative reaction from DEC clients – FMB's objection is that they already pay VHS staff salaries to provide this service, so they will not agree to pay twice. Consequence: working relationship with clients is severely damaged. 2. Large added cost, even at discounted rates, for Science Division's research project budgets where VHS services are required (currently there is no charge). 3. Large added cost for Special Project budgets where VHS services are required. Example: VHS has processed approx. 1,180 samples for the BCI since July 2006, for no charge. At $77 per sample, the cost of processing such numbers would be prohibitive. 4. Imposing a charge for DEC clients gives a **major disincentive** to doing adequate sampling, and re-sampling. Consequence: a dramatic reduction in the numbers of samples sent to VHS for processing, due to the cost – this would be highly **counter-productive** to the overall aims of Dieback management. VHS staff have been striving for many years to encourage the use of the VHS services by DEC staff, and for key conservation areas to be re-sampled regularly. 5. The reduction in sample numbers leads to a corresponding reduction in VHS revenue – so the imposition of charges would be self-defeating on this basis.

6.3 Scenario 3: Close the VHS down, outsource its functions, and reallocate its resources within Science Division

For	Against
1. One FTE (Level 2-3, occupied on a job-share basis), plus 0.3 of one Level 5 FTE, plus $5,000 p.a. budget allocation, available for re-allocation in the Division.	1. Closure of the VHS would be widely seen externally as a "cop-out" by DEC, in terms of fulfilling its **leading role** in WA Dieback management. 2. No other WA operator can offer anything like the **scale of operation** for sample processing that is done by the VHS, nor its flexibility in being able to schedule and process large sample batches at short notice. 3. **Large added cost** for FMB Interpreters, Science Division project budgets, and others where VHS services are required. [Charges by other service providers in 2006 were from ~$85 to ~$130 per sample.] 4. **Large added cost** for Special Project budgets where VHS services are required. Example: VHS has processed approx. 1,180 samples for BCI since July 2006, for no charge. At eg $100 per sample, the cost for this project alone would be completely prohibitive, using external service providers, at $118,000. 5. Dramatic reduction in numbers of samples sent for processing, due to costs – this would be **highly counter-productive** to the overall aims of Dieback management. VHS staff have been striving for many years to encourage the use of the VHS services by DEC staff, and for key conservation areas to be re-sampled regularly. 6. Loss of "community good" aspects of the provision of services and expertise by the VHS, within Science Division and DEC. 7. **ALL other "For" items (# 1 - 15) listed in Scenario 1 above would be lost**.

7. Phytophthora Dieback Management – the VHS Role in Perspective

Phytophthora Dieback was listed as a **Key Threatening Process** under the Commonwealth's *Environment Protection and Biodiversity Conservation Act, 1999*. In the South-west Botanical Province of Western Australia, it has been estimated that 2,284 species of the 5,710 described native plant species are susceptible to the pathogen *P. cinnamomi* (Shearer et al., 2004). *P. cinnamomi* is already widespread, but every effort must be made to protect non-infested sites that are considered 'protectable', especially where endangered taxa of flora or fauna, or rare ecosystems, are present. **Effective and accurate monitoring of the presence and spread of *P. cinnamomi* is therefore fundamental to its management**. A **Key Strategic Goal** of Science Division, in relation to understanding and managing threats to biodiversity in WA, is "To determine the distribution of *P. cinnamomi* …" (**G 2.21**).

The VHS is playing a vital role in achieving this goal, under its current operation.

Recent work by VHS and CPSM has shown, unexpectedly, that **ten or more new and undescribed species of *Phytophthora*** are present in WA native ecosystems, and in addition, there have been new WA records of several named Phytophthoras (eg, Stukely *et al*., 2007 (b); Stukely *et al*. 2007 (c)). Both recent and historic *Phytophthora* isolates are involved. [These Phytophthoras are now being investigated further, through the CPSM, to determine the level of threat they pose, and to facilitate the development of control and intervention strategies should they prove to be necessary.] This clearly aligns with the Science Division's **Key Strategic Goal G 2.7**, "Undertake a state-wide risk analysis of biodiversity threats and likely impacted species and communities …" Virtually all *Phytophthora* species have pathogenic capability on some plant species, and these new species and new records of *Phytophthora* have already been associated with dying plants in natural vegetation in WA. Improved knowledge of these pathogens will lead to more effective management of the threats they may pose, and the VHS is playing an important part in providing this knowledge.

A key aspect of the ongoing management of Phytophthora Dieback will continue to be the availability of the VHS as a well-established and efficient diagnostic lab, with staff who are highly experienced in this work and well acquainted with the needs of DEC's land managers and scientists. It is important that DEC is ***seen*** to be taking the lead role in doing this work in WA, in an efficient and cost-effective, science-based, and adaptive way.

The following important and pertinent points are also noted here:

1. The VHS rightly belongs in DEC's Science Division because of the type of specialist, scientific service it provides. We can then ensure that its work is always based on **sound science** and that the necessary standards are maintained; also, interaction and collaboration with external scientific institutions is facilitated. The provision of a specialist, scientific service of this nature is as much a part of Science Division's broad role in the Department as are its research projects.

2. The staff are highly trained and experienced in the specialised aspects of the VHS work – there are very few other labs nation-wide that can identify *Phytophthora* to species level as a routine job. It is worth noting that in the other establishments that can do this, in Australia and overseas, the people doing the hands-on work of identifying *Phytophthora* are generally fully trained Mycologists, at a much higher level than VHS staff (eg Scientist, rather than Technician). This work of our VHS staff should not be undervalued, or dismissed as inconsequential, in the overall context of Science Division's activities. Their work is every bit as specialised as that of a DNA lab, for example.

3. Only two other labs can carry out routine *Phytophthora* testing in WA currently – the Department of Agriculture and Food (DAFWA) Plant Pathology Section in South Perth, and Dr Elaine Davison at Curtin University. DAFWA, however, will normally not now identify isolates to species.

4. While the testing of samples and isolation and identification of cultures is routine work, it requires constant careful attention and scientific application, and the maintenance of very high and consistent standards. *Phytophthora* species other than *P. cinnamomi* are regularly encountered. Evidence of the success of this approach is that VHS staff have recently discovered several *Phytophthora* species that are new to science, as well as obtaining new records for WA of several named *Phytophthora* species (eg, Stukely *et al*., 2007 (b); Stukely *et al*. 2007 (c)).

5. In addition to the routine testing of samples for *Phytophthora* and identifying the *P.* spp. that are found, the VHS maintains a large and growing culture-collection of *Phytophthora* spp. that is available to researchers (both Departmental and external). Currently there are over 1,500 different live cultures in the Collection, plus backups, and most were isolated from native WA forest and heath-land sites. This is by far the most extensive *Phytophthora* collection in WA, and it is a unique and very valuable research resource. The Department of Agriculture and Food holds a major culture collection that covers a wide range of pathogenic and other organisms, but this includes only 91 Phytophthoras – most of which are from horticultural, agricultural or nursery sources.

6. The importance of culture collections is recognised worldwide as a research resource, and for assisting in the response to present and future disease challenges. It is imperative that the DEC collection continues to be maintained and held by this Department.

7. A database of all samples processed by the VHS and their test results, both positive and negative, is also maintained and continually updated (the database now holds over 31,000 records, covering samples from all VHS clients from 1982). This can be used to extract information as required, and to generate *Phytophthora* species distribution maps. There is also a very large permanent data set comprising the measurements of structures (sporangia, oogonia, oospores, etc) and descriptions of the key features of all *Phytophthora* isolates that have been identified by the VHS.

8. The services of the VHS are in some ways analogous to those of the Herbarium in the provision of specialist, scientific services – the identification of specimens, maintaining a reference culture collection that is available to others as a research resource, data-basing samples tested and specimens retained, documenting the geographic distribution of species, etc. It is therefore highly appropriate that the VHS should remain in the DEC Science Division's **Flora Conservation and Herbarium Program.**

9. The VHS (and its facilities) was included as part of DEC's contribution to the **Centre for *Phytophthora* Science and Management (CPSM)** at Murdoch University. The VHS can provide its *Phytophthora* isolation and identification service, as well as maintaining the culture collection and databases, for the Centre's benefit. This is a positive and worthwhile collaboration between scientific institutions, and VHS staff have developed an excellent, strong and mutually beneficial working relationship with CPSM.

8. Can Molecular (PCR) Testing for *Phytophthora* Replace Baiting?

Answer: No.

A very promising technique utilising the polymerase chain reaction (PCR) has been developed recently at Murdoch University for the detection of *P. cinnamomi* (only) in field soil samples. This is a different and separate procedure from the DNA sequence analysis of isolates carried out by CPSM for *Phytophthora* species identification (which uses pure cultures of *Phytophthora* that can only be obtained from soil/root baiting or root isolations).

In theory, the PCR technique should allow faster turnaround times for sample test results than the baiting procedures used in the VHS. However, comparisons of PCR with baiting carried out by VHS and CPSM in 2007 have shown clearly that further development is necessary to improve the reliability of the PCR method – this largely stems from sampling problems, especially where the *P. cinnamomi* inoculum levels in soil are lower.

Current limitations on PCR testing for *P. cinnamomi* (as opposed to baiting) include:

- Reliability – the quantity of material sampled for testing is not adequate to ensure detection when *P. cinnamomi* is present. False-negative results are the outcome.
- No *Phytophthora* isolates can be captured for further testing and research [unless the standard baiting procedure is **also** done, with its associated additional time and cost].
- Phytophthoras other than *P. cinnamomi* are not detected by PCR. [Methods for this are yet to be developed.]
- Mating types (A1 or A2) of any *P. cinnamomi* that is detected cannot be determined [unless pure cultures are first isolated].

Assuming that PCR can be developed as a reliable test method, and to be applicable for all species of *Phytophthora*, the baiting of samples (as done by the VHS) will still be required in parallel with PCR to provide isolates of the *Phytophthora* pathogen(s) that are present.

9. Recommendation

The VHS should continue to operate within the DEC Science Division's Flora Conservation and Herbarium Program as at present, and provide its services without charge to all DEC clients. This will enable the needs of land managers and Scientists to be addressed in a timely, well-informed and efficient way, by the highly experienced VHS staff. Routine testing of samples for *Phytophthora* will then be encouraged, rather than discouraged (due to cost), to the benefit of Dieback management generally. The other major outputs of the VHS such as the *Phytophthora* databases, and *Phytophthora* culture collection, will continue to be developed and maintained, and to be made available to managers and researchers, without interruption. The mutually beneficial collaborations that now exist will continue to flourish.

10. References

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