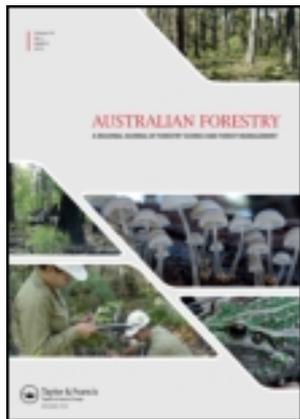


This article was downloaded by: [Chela Powell]

On: 15 May 2013, At: 15:54

Publisher: Taylor & Francis

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## Australian Forestry

Publication details, including instructions for authors and subscription information:  
<http://www.tandfonline.com/loi/tfor20>

### Development of a threatened fauna management framework across Victoria's state forests

C.J. Powell <sup>a</sup> & D.N. Sedunary <sup>a</sup>

<sup>a</sup> VicForests, GPO Box 191, Victoria , Melbourne , 3001 , Australia

To cite this article: C.J. Powell & D.N. Sedunary (2013): Development of a threatened fauna management framework across Victoria's state forests, Australian Forestry, 76:1, 10-15

To link to this article: <http://dx.doi.org/10.1080/00049158.2013.776922>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.tandfonline.com/page/terms-and-conditions>

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae, and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

## Development of a threatened fauna management framework across Victoria's state forests

C.J. Powell<sup>1,2</sup> and D.N. Sedunary<sup>1</sup>

<sup>1</sup>VicForests, GPO Box 191, Melbourne, Victoria 3001, Australia

<sup>2</sup>Email: [chela.powell@vicforests.com.au](mailto:chela.powell@vicforests.com.au)

Revised manuscript received 28 September 2012

### Summary

Biodiversity conservation is a vital part of ecologically sustainable forest management. It is undeniable that the diversity (of genes, species and ecosystems) is fundamental to ecosystem function and therefore forest health. Victoria's state forests are managed in accordance with some of the world's highest standards of forest management. VicForests, which is responsible for native timber harvesting within Victoria's state forests, has developed a threatened species management framework that is complimentary to the existing legislative requirements governing threatened species management across the state. This management framework involves surveying for threatened fauna species in areas available for timber harvest to further improve the management and protection of key threatened species and their habitat.

This paper is a review of VicForests pre-harvest fauna survey process and targeted monitoring projects, outlining the results and survey effort undertaken over the past year, and how this process has contributed to the conservation of a range of threatened species across eastern Victoria. This review also considers potential improvements to the framework that may drive further development in the future. This information is relevant to all forest management agencies that are faced with the delicate task of balancing the management of multiple forest uses with biodiversity conservation.

Since implementation, this process has improved how VicForests manages areas planned for harvest, providing a more comprehensive multi-tiered system that seeks to protect biodiversity values while considering external variables and elements of a sometimes complex regulatory framework. Large areas of forest potentially available for harvest have been excluded from operations by VicForests through this process. This could be seen as a loss of resources to business, but the benefit of having a system in place that is managed in-house and that develops and broadens VicForests understanding of the values within the forest estate has been a significant step forward. For the native timber industry to continue well into the future it is important to sustain the functionality of forested environments that supply the timber that we harvest.

*Keywords:* forest management; sustainability; biodiversity; conservation; logging effects; fauna; regeneration

### Introduction

The loss of biodiversity has widespread implications for both human and environmental sustainability. Biodiversity—the variety of species and their habitats—provides a wide range of ecosystem services including nutrient and water cycling, soil formation and retention, resistance against invasive species, plant pollination, climate regulation, and pest and pollution control, to name a few (Diaz *et al.* 2005; Mace *et al.* 2005). It is undeniable that biodiversity is fundamental to ecosystem functioning and consequently forest health. The conservation of biodiversity is therefore a vital part of ecologically sustainable forest management. Forest management practices such as timber harvesting, roading, fuel reduction burning and pest management also shape local and regional biodiversity, indicating that forest management and biodiversity cannot be separated (Wilson 1993). There has been significant conflict between the forestry industry and the environmental movement regarding the disturbance caused by native forest harvesting, which has meant that forestry is often viewed as an industry completely separate from, if not in opposition to, biodiversity management.

Victoria's state forests are managed in accordance with some of the world's highest standards of forest management. The first objective of the *Sustainability Charter for Victoria's State Forests (2006)*, one of the key instruments instructing forest management, is to maintain and conserve biodiversity. Areas available for harvest are subject to a comprehensive regulatory framework that imposes a range of restrictions on operations (VAFI 2011); this framework includes a wide range of legislative instruments and Acts to which VicForests must adhere.

There are about 7.8 million hectares of native forest in Victoria (ABARES 2011); much of this area is either unavailable or unsuitable for timber production. An area of 4.8 million hectares of forest is protected in national parks and conservation reserves, with the aim of ensuring that the flora and fauna of Victoria are comprehensively represented across these areas. VicForests is a state-owned business responsible for the sustainable harvest, regeneration and commercial sale of timber from

Victoria's public forests on behalf of the government. Of the area available for harvest, VicForests annually harvests about 5500 ha or less (0.1%) (VicForests 2011).

Harvesting of state forest is planned in line with legislative requirements and proposals are forwarded to the Department of Primary Industries (DPI) for approval. In addition, VicForests undertakes a range of other measures to ensure that any threatened species within areas planned for harvest are managed appropriately. This management begins at the coupe reconnaissance level and is carried through harvesting until the coupe is regenerated and responsibility for the site is returned to the Department of Sustainability and Environment (DSE). VicForests pre-harvest survey hierarchy (see Fig. 1) outlines measures taken to identify and protect biodiversity and other core forest values before operations begin.

This hierarchy consists of four key stages:

1. **Desktop assessment:** All coupe areas planned for harvesting undergo a desktop assessment in the form of a coupe overlay analysis, to check for values already identified and mapped in a particular area. This check uses Geographic Information System (GIS) records and in particular, identifies areas of the coupe that may require consideration and further adaptive management. One of the key layers used during this process is the Victorian Biodiversity Atlas (VBA) which checks previous records of flora and fauna species.
2. **Coupe transect:** All coupes planned to be harvested undergo a field survey: walking a transect to search for threatened species and/or threatened species habitat, in addition to a range of other coupe features. The transect also targets threatened vegetation communities to ensure that they are managed appropriately and, where required, buffered from operations.
3. **Targeted species surveys:** These pre-harvest fauna surveys are determined in accordance with a risk-based framework,

identifying areas where harvesting may impact on threatened species. Surveys target particular threatened species and survey results identify the need for any further management actions.

4. **Targeted research and monitoring:** This occurs where coupe-level surveys may be less effective for species with large home ranges that occupy a range of forest areas. In this case, broader research or monitoring projects assist in further managing a particular species or community, while also providing valuable information about faunal use of different vegetation types and age classes across the landscape.

VicForests pre-harvest surveys and targeted research as outlined above are entering their second year. This review focuses on the results of this newly developed biodiversity management framework, and how this process is contributing to the conservation of a range of threatened species across eastern Victoria. The review also considers some of the potential improvements that may be made to the framework in the future. Information provided in this review is relevant to other native forest agencies faced with the similar task of managing the delicate balance between timber production and biodiversity conservation.

## Survey framework

VicForests' pre-harvest fauna surveys are a precautionary, risk-based approach to threatened species management. These surveys have been developed to provide an additional guide to aid in the implementation of precautionary measures for threatened species protection, to avoid (a) the threat of serious or irreversible environmental damage (where such threat has some scientific basis); and where (b) there is scientific uncertainty around the environmental impact of operations.

Coupes that require surveys are identified by the process illustrated in Figure 2. Pre-harvest surveys are conducted in the following circumstances:

1. The coupe displays rare and limited characteristics, meaning the area is modelled as 'Old Growth' (on the GIS overlay that has information about the extent and distribution of old-growth forest across the state), or is found to contain old-growth characteristics that have not been disturbed and where therefore operations have a potential to cause serious or irreversible damage.

**and** where one or more of the following also apply:

2. The coupe is subsequently found to be within a 'Wet' Ecological Vegetation Class (EVC) (typically represented by EVCs 16, 18, 29, 30, 31, 32, 35, 38 and 39) (see DSE 2012 for EVC descriptions). This represents the primary habitat of a number of target species.
3. The coupe subsequently displays threatened fauna habitat or has records of previous species sightings as identified in the coupe overlay process (using DSE-approved VBA data).

**or,** alternatively to points 1–3 above:

4. The coupe displays characteristics which VicForests considers warrant a survey (such as additional issues/values that are outside the points 1–3 above, and are identified during planning).

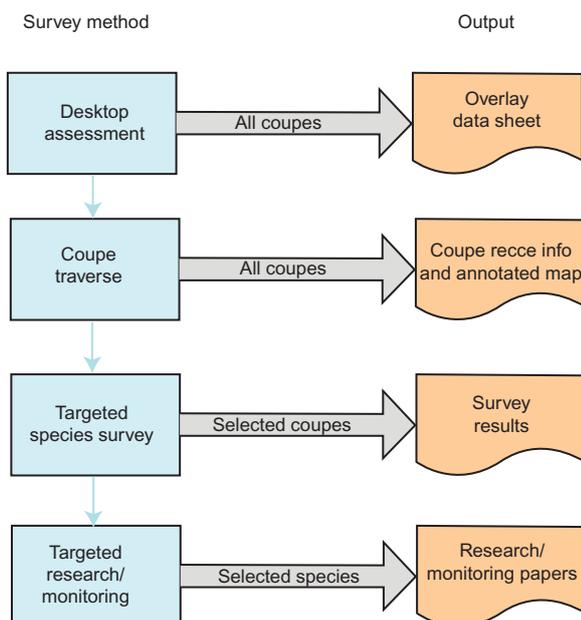
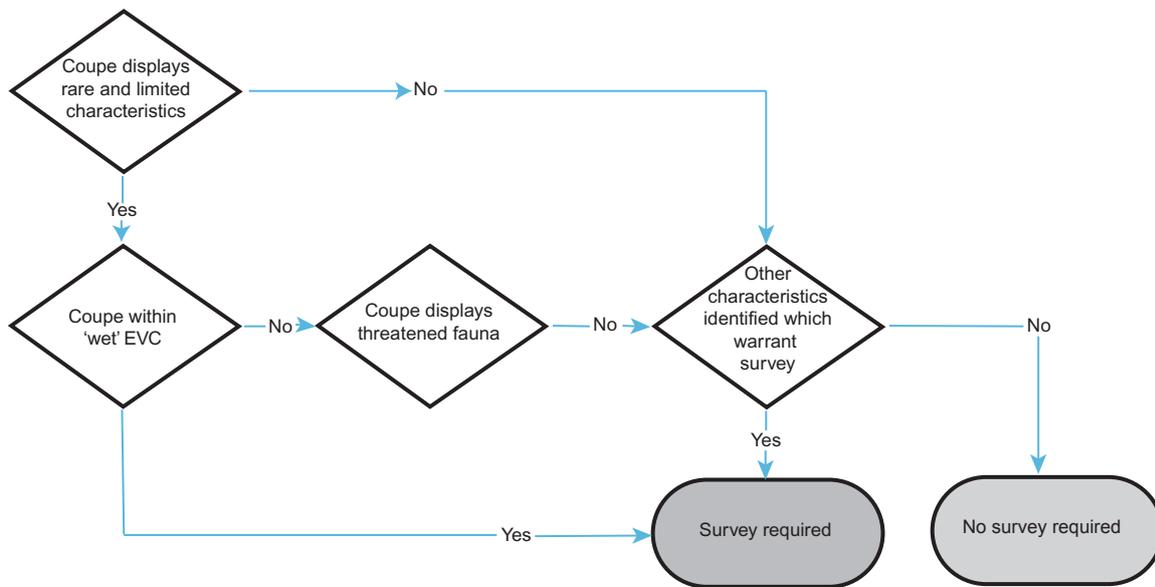


Figure 1. Survey methods and associated outputs



**Figure 2.** Targeted survey site-selection framework

### Pre-harvest survey methods

Pre-harvest surveys target threatened fauna species in a range of taxonomic groups known to occur in areas where harvesting operations are proposed. VicForests used advice from species experts as well as peer-reviewed literature to choose appropriate survey methods to detect target species. Methods selected were those that are well known, commonly used, effective and practicable. Pre-harvest survey operating procedures are continually updated and refined in response to knowledge gained from surveys and new information that comes to light, ensuring an overall adaptive approach to threatened fauna management. A range of survey methods is used for pre-harvest fauna surveys including remote camera surveys, spotlighting surveys, nocturnal call play-back surveys (Loyn *et al.* 2001), active searches of riparian areas and walking transects. Any additional features found within the areas planned for harvest, as well as any opportunistic fauna sightings, are also recorded. These features include any live or dead specimens or any part of the animal including a sign that indicates their presence.

Surveys are carried out by appropriately qualified external ecological consultants reporting to VicForests' Conservation Biologist. When a threatened species is detected, adaptive management plans are created to address the protective requirements for the specific animal detected. These plans outline areas that are to be retained as habitat for the animal or the habitat feature detected (such as a nest or a roost site). These plans, as a minimum, adhere to prescriptions outlined in the regulatory framework (Forest Management Plans or *Flora and Fauna Guarantee Act (1988) Action Statements*).

All threatened species detections are reported to DSE so that information about their location can be added to the VBA. This process of reporting means that valuable information about the location of these animals is being fed back into the forest planning process, allowing continual improvement in planning of areas required for the persistence of these animals across the landscape.

### Monitoring across the landscape

Coupe-level surveys may not be the most appropriate scale of survey to detect species that occur across large home ranges, requiring large areas for their survival. To address this, VicForests has implemented a further level of species monitoring which assesses the presence of particular threatened species across the landscape. This monitoring is carried out over extended periods taking into account possible seasonal variation in occurrence and activity. VicForests' monitoring is designed to complement other landscape-scale projects such as those undertaken by DSE, Southern Ark and other research institutions.

This approach to monitoring allows a consideration of the spatial and temporal variability inherent in natural systems, while providing valuable information that can be fed into the planning and decision-making process. The approach acknowledges that traditionally forestry has often concerned itself with individual stands, with less emphasis on issues that occur across larger spatial scales even though some of these are of overwhelming importance (Kohm and Franklin 1997). Although extended, large-scale monitoring projects require significant effort and resources, such information is important for adaptive, long-term management of sensitive forest fauna. The aim of these longer-term, large scale monitoring projects is to provide guidelines for making decisions on how best to manage the landscape for the production of timber resources while at the same time maintaining, or even enhancing, local biological diversity (Niemelä 2000).

### Results

Although the data from both pre-harvest surveys and landscape-scale monitoring projects have been gathered over a short ecological period, the results thus far indicate that a range of threatened fauna, with relatively selective habitat requirements, are present within areas that have been

extensively managed for timber production since the 1850s (DAFF 2007).

From pre-harvest surveys across 100 coupes, which equates to about 9500 camera nights, and over 100 call playback and spotlighting nights, a wide range of threatened species have been detected, including:

- 47 long-footed potoroos (*Potorous longipes*) (detected at 47 separate sites)
- 17 sooty owls (*Tyto tenebricosa*), either observed via spotlight or heard, including 4 breeding pairs
- 2 masked owls (*Tyto novaehollandiae*), either observed via spotlight or heard
- 8 powerful owls (*Ninox strenua*), either observed via spotlight or heard, including 2 breeding pairs
- 87 records of yellow-bellied gliders (*Petaurus australis*) (either observed or heard)\*
- 40 greater gliders (*Petauroides volans*) (observed)\*
- 8 glossy black-cockatoos (*Calyptorhynchus lathamii*)
- 2 Orbost spiny crayfish (*Euastacus diversus*).

\*Yellow-bellied gilders and greater gliders are not threatened individually and do not require adaptive management plans for their protection unless they occur in dense populations.

Threatened-fauna detections in areas planned for harvest result in the development of adaptive management plans. These plans ensure that harvesting is excluded in areas that are deemed as suitable habitat for the species, within the vicinity of the detection, with plans following the relevant legislative requirements for the animal's protection. To date this includes an area of about 4820 ha that has been retained from either pre-existing reserved areas (SPZ) or areas available for harvest (2692 ha). Development of these plans is done in consultation with DSE, and habitat selected for retention is based on the habitat requirements of the particular species, not necessarily land tenure.

### Long-footed potoroo

Long-footed potoroos are listed federally as endangered under the *Environment Protection and Biodiversity Conservation Act EPBC (1999)* and as threatened under the *Flora and Fauna Guarantee Act (FFG) (1988)*, with their population being estimated as no more than 10 000 individuals (DSE 2009). With verified detection at almost 50 sites by VicForests pre-harvest surveys, highly valuable information has been added to the distribution of this species across the East Gippsland region, indirectly contributing to their conservation.

VicForests has developed long-footed potoroo adaptive management plans that apply to an area of about 3930 ha, with more currently being developed as new occurrences arise. The East Gippsland distribution of long-footed potoroo has long been thought to be bounded by the Bemm River, Princes Highway, Yalmy Road and Gap Road. VicForests monitoring and pre-harvest surveys have detected three individual long-footed potoroos outside the known range of the species, east of the Bemm River. This is a highly significant finding extending the known distribution of the species.

### Forest owls

A range of threatened forest owls such as the sooty, powerful and masked owl have been detected regularly across coupes surveyed. In particular the sooty and powerful owls have been detected frequently, while the masked owl has only been detected on a few occasions. Each of these forest owl species is listed as threatened under the *FFG Act (1988)*, with the Victorian populations being estimated as 400–900 breeding pairs of sooty owl and about 500 breeding pairs of powerful owl, while the population of masked owls in Victoria is not known (261 individual records in Victoria). There were 27 separate detections (either heard or seen) of threatened forest owls in total, while two breeding pairs of powerful owl and four breeding pairs of sooty owl were detected. In order to appropriately protect breeding pairs, VicForests has created protective owl management plans that cover a total area of 2500 ha.

### Arboreal marsupials

Yellow-bellied and greater gliders are not currently listed as threatened species at the state or Federal level, but the *East Gippsland Forest Management Plan (DSE 1995)* prescribes that when these species occur in high densities (which is a rare occurrence) the populations must be protected. At one particular coupe where this density requirement was met for the yellow-bellied glider, VicForests applied a management plan that assigned an area of 100 ha to protect the community.

### Crayfish

The Orbost spiny crayfish is listed as threatened under the *FFG Act (1988)*. The population density of this species is unknown, and little is known about its biology or taxonomy. Pre-harvest surveys detected two possible individuals of this species, but neither could be clearly identified by species experts. Because of the taxonomic uncertainty, VicForests took a precautionary approach and created an adaptive management plan for each recorded crayfish that equated to a total area of 40 ha (as per the Orbost spiny crayfish *Action Statement*).

### Spot-tailed quoll

The spot-tailed quoll is a forest-dependent carnivorous marsupial that can occupy home ranges of up to several thousand hectares (Nelson *et al.* 2008). This species is listed as endangered by the *EPBC Act (1999)* and under the *FFG Act (1988)*. Pre-harvest surveys for this species have to date not detected the presence of spot-tailed quoll in any areas planned for harvest. Furthermore, landscape-scale surveys for spot-tailed quolls have not detected any quolls across various land tenures in the Central forest management area. However, as landscape-scale monitoring for spot-tailed quolls has occurred over a relatively short ecological period, and only during spring, summer and winter, it is particularly important to carry on with the landscape-scale approach to spot-tailed quoll management.

## Amphibians

A suite of threatened amphibian species occurs across areas where harvesting operations are permitted. Although there have been active searches for these species across both riparian and forest areas during pre-harvest surveys, none has been detected.

Frogs, due to their cryptic nature, are notoriously difficult to survey as their emergence often coincides with very specific weather conditions and during breeding periods (which may be for only one month of the year). The key species of threatened frogs that have the potential to occur in the areas planned for harvest are the giant burrowing frog (*Heleioporus australiacus*) and the large brown tree frog (*Litoria littlejohni*).

There are very few recent records of large brown tree frog in Victoria (Scroggie *et al.* 2011). According to these authors, at present the probability of detecting this species using any survey method is unknown, with no one method of survey suggested as optimal for detecting this species. There are similar issues of lack of knowledge regarding appropriate methods to detect giant burrowing frogs. Clemann *et al.* (2011) described the giant burrowing frog as a species that is cryptic and notoriously difficult to detect. The *Code of Practice for Timber Production* (DSE 2007) states that riparian vegetation within 20 m of running waterways must be excluded from operations, which provides some protection for these species.

## Threatened fauna management in the future

As VicForests approach to biodiversity management seeks to be adaptive, it is important to review whether the current process is optimal for the objective of managing biodiversity to the best of VicForests capacity. The fauna survey techniques employed thus far have been efficient in the detection of target species, and have proven to successfully mitigate the initial risks of uncertainty identified before the threatened species framework was put in place. However, a number of recommendations regarding these methods need to be considered when looking at on-going improvements of the current processes.

## Survey scale

VicForests pre-harvest surveys for species presence have to date been undertaken at the coupe level, and surveying is carried out on a year-round basis across a range of geographically separated coupes. The spatial and temporal scales at which these surveys are undertaken are not necessarily the most efficient for survey of all fauna in regards to both the patterns of habitat use by animals and the use of survey resources. This is particularly the case for amphibian surveys. Frogs are particularly cryptic in their nature but are known to be more active during periods coinciding with rainfall, other particular weather conditions and during breeding periods. Amphibian surveys at broader spatial scales could provide a basis for more detailed surveys of an increased area of potential habitat of these species, choosing the sites and specific seasonal conditions known to be preferred by the target species.

## Compartment assessments

A move towards compartment-scale surveys for selected fauna could improve species detectability and survey efficiencies. A compartment is defined as a forest management unit that is continuous and bound by recognisable landscape features. Forests NSW undertakes surveys for a number of species based on a landscape approach that provides improved potential to carry out rigorous surveys at a greater scale once or twice each year (DEH 2011).

These compartment-scale surveys could concentrate on particular seasons or conditions, in line with known activity patterns and habitat requirements of target species across the broader landscape. For example, surveys for spot-tailed quolls could be carried out across targeted compartments where rocky outcrops (the species preferred den sites) are present, during the winter months when this species is most active. It must be kept in mind that harvesting operational schedules may not make seasonal and landscape-scale surveying possible in all cases, and therefore some level of coupe-level survey will probably always be required for some target species and in some specific cases.

Where surveys are carried out at larger spatial scales there is potential to broaden the range of vegetation types and age classes surveyed, providing a more holistic understanding of the distribution of threatened species across the landscape. This information would in turn contribute to knowledge of the distribution and habitat requirements of these species, an outcome that does not always result from surveys at smaller spatial scales. The move towards landscape-scale surveys may also provide an opportunity to gather additional information regarding habitat requirements of threatened species, assisting in better defining the optimal habitat for a given species. This in turn would help to refine the trigger for inducing a survey in a given coupe and/or compartment.

The pre-harvest survey framework was initially developed with the primary aim of managing the risk associated with scientific uncertainty and the potential to cause irreversible damage to the environment. The framework has been successful in achieving the management of these risks while also allowing continued operations. The key challenge for the future is to go beyond just managing risk by ensuring that the significant effort that is entailed in the pre-harvest survey process also provides useful information about the distribution and habitat requirements of threatened species, in turn improving forest management planning.

## Faunal use of regenerating forests

Another facet of biodiversity management in timber production forests is understanding the role that regenerating areas may play in the provision of habitat and/or food resources for local fauna. Harvesting of timber across the landscape is a disturbance that creates a mosaic of regenerating forests of differing ages (DiStefano *et al.* 2009). A range of authors suggest that regenerating forests can play an important part in biodiversity conservation, but little is known about the relationship between fauna and the resources supplied by different forest age classes (Alexander *et al.* 2002).

There would be value in pursuing research in this area, investigating the capacity of local fauna to return to areas of regenerating forest and whether they are actually utilising these areas, in turn providing a better overview of the effects of timber harvesting on the functionality of the landscape.

## Conclusions

VicForests' approach to biodiversity management is one that seeks to be adaptive, using the most accurate and effective methods to assist and support decision-making processes. According to Kohm and Franklin (1997), it is particularly important to understand that we, as decision-makers and environmental managers, adopt humility as a basic attitude in all approaches to forests—whether as scientists, advocates, managers or policy-makers. With this in mind, VicForests' adaptive approach to biodiversity is a significant step forward in continued sustainable forest management.

This newly implemented process has improved how VicForests manages areas planned for harvest, ensuring a more comprehensive multi-tiered system that seeks to protect biodiversity values while also providing the timber requirements of dependant businesses in a sustainable manner. Large areas of state forest potentially available for harvest have been excluded by VicForests through this process. This could be seen as a loss of resources to business, but the benefit of having a system in place that is managed in-house and that develops and broadens VicForests understanding of the values within the forest estate has been a significant step forward. The outcomes of VicForests threatened species surveys and monitoring are indirectly helping to sustain the industry in the long term by incorporating the management of biodiversity with that of timber harvesting.

The incorporation of this recently developed threatened species management protocol as a key element of business highlights the required link between management of the environment and its values with that of economic return. For the native timber industry to continue well into the future, it is essential to sustain the ecological processes behind the functionality of the forested environments which supply the timber that we harvest. It is the variety of life at the genetic, species and ecosystem levels that is the supportive mechanism behind the growth of resources such as timber. Now more than ever it is essential that biodiversity management is a significant component of everyday operational considerations, as the multiple use of the forest for both timber production and biodiversity conservation cannot be dissociated if forests are to be managed in an ecologically sustainability manner.

## References

Alexander, J.S.A., Scotts, D.J. and Loyn, R.H. (2002) Impacts of timber harvesting on mammals, reptiles and nocturnal birds in native hardwood forests of East Gippsland, Victoria: a retrospective approach. *Australian Forestry* **65**, 182–210.

ABARES (2011) *Australia's Forests at a Glance 2011*. Australian Bureau of Agricultural and Resource Economics and Science, Commonwealth of Australia, Canberra.

Clemann, N., Scroggie, M. and Lumsden, L. (2011) *Survey Standards: Giant Burrowing Frog* *Heleioporus australiacus*. The Department of Sustainability and Environment, Melbourne.

DAFF (2007) *East Gippsland Victoria: Resource and Economic Report*. Department of Agriculture, Fisheries and Forestry. <http://www.daff.gov.au/rfa/regions/vic-eastgippsland/resource/economics> (viewed 12 February 2012).

DEH (2011) *Terms of Licence under the Threatened Species Conservation Act 1995*. Eden. Department of Environment and Heritage. <http://www.environment.nsw.gov.au/forestagreements/edenagreement.htm> (viewed 5 July 2012).

Diaz, S., Tilman P. and Fargione, J. (2005) Biological regulation of ecosystem services. In: Hassan, R., Scholes, R. and Ashe, N. (eds) *Ecosystems and Human Wellbeing, Current State and Trends*. Island Press, Washington DC, pp. 315–317.

Di Stefano, J., York, A., Swan, M., Greenfield, A. and Coulson, G. (2009) Habitat selection by the swamp wallaby (*Wallabia bicolor*) in relation to diel period, food and shelter. *Austral Ecology* **34**, 143–155.

DSE (1995) East Gippsland Forest Management Plan. Victorian Government, Department of Sustainability and Environment, Melbourne.

DSE (2007) Code of Practice for Timber Production. Victorian Government, Department of Sustainability and Environment, Melbourne.

DSE (2009) Long-footed Potoroo (*Potorous longipes*). Action Statement No. 58. Victorian Government, Department of Sustainability and Environment, Melbourne.

DSE (2012) *Ecological Vegetation Class (EVC) Benchmarks for each Region*. Victorian Government, Department of Sustainability and Environment, Melbourne. <http://www.dse.vic.gov.au/conservation-and-environment/native-vegetation-groups-for-victoria/ecological-vegetation-class-evc-benchmarks-by-bioregion> (viewed 25 September 2012).

*Environment Protection and Biodiversity Conservation Act (1999)*. Australian Government, Canberra.

*Flora and Fauna Guarantee Act (1988)*. The Parliament of Victoria, Melbourne.

Kohm, K. and Franklin, J.F. (1997) *Creating a Forestry for a 21st Century*. The Science of Ecosystem Management. Island Press, Washington DC.

Loyn, R.H., McNabb, E.G., Volodina, L. and Willig, R. (2001) Modelling landscape distribution of large forest owls as applied to managing forests in north-east Victoria, Australia. *Biological Conservation* **97**, 361–376.

Mace, G., Masundire, H. and Baillie, J. (2005) Biodiversity, Millennium Ecosystem Assessment: current state and trends: findings of the Condition and Trends Working Group. In: Hassan, R., Scholes, R. and Ashe, N. (eds) *Ecosystems and Human Wellbeing, Current State and Trends*. Island Press, Washington DC, pp. 77–122.

Nelson, J., Scroggie, M., Woodford, L. and Robley, A. (2008) *Assessing the Distribution and Status of the Spot-Tailed Quoll Population of the Otway Ranges, South West Victoria*. Arthur Rylah Institute for Environmental Research, Melbourne.

Niemelä, J. (2000) Biodiversity monitoring for decision-making. *Annales Zoologici Fennici* **37**, 307–317.

Scroggie, M., Clemann, N. and Lumsden, L. (2011) *Survey Standards: Large Brown Tree Frog* *Litoria littlejohni*. The Department of Sustainability and Environment, Melbourne.

VAFI (2011) *Sustainability Report 2011*. Victorian Association of Forest Industries (VAFI), Melbourne.

VicForests (2011) *Sustainability Report 2010–11*. [www.vicforests.com.au](http://www.vicforests.com.au).

Wilson, E.O. (1993). Foreword. In: Aplet, G.H., Olson, J.T. and Sample, V.A. (eds) *Defining Sustainable Forestry*. Island Press, Washington DC.