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Report to Forestry Tasmania on Application of Variable Retention Silviculture and Related Biodiversity Issues

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How I interpreted my charge:

1. Provide advice on scientific basis and ecological outcomes associated with implementing variable retention silviculture (VR) in old-growth coupes on Forestry Tasmania lands as replacement for the Clearfell Burn and Sow (CBS) practices.

2. Comment on other related aspects of forest management and conservation

Background

The high social and ecological values of old-growth forests have become globally recognized over the last 20 years. Where large areas of old-growth forest still remain, management conflicts can be severe. The challenge to forest managers in these situations is to integrate diverse forest management goals including ecological, social and economic. There is no easy way to accomplish this as experiences in Canada, the U.S. Pacific Northwest and Australia indicate. Often the choice has been framed as between large reserves or high yield timber production of native or non-native species. This black and white thinking is not only problematic from the stand point of conflict resolution, it is also not the best way to insure long-term maintenance of biodiversity.

In recent years research from forest ecology, disturbance ecology, silviculture, conservation biology, and landscape ecology has lead to the development of alternative approaches to resolving these conflicts. These alternatives, which include variable retention silviculture (VR), are based on the following scientific findings and principles:

1. Old-growth is a stage of succession/stand development that is typically distinctive in structure, composition, and/or process.
2. The details of old-growth forest ecology vary among forest types and with site history; characterizations and practices from one type may not apply to other types.
3. Old growth forests are not static and many of their distinctive attributes are a product of continuing successional change and disturbances of various intensities

4. Old-growth forests are part of a continuum of structural and compositional change and there are no clear thresholds that make it easy to define an old-growth stage from younger stages.
5. At a landscape level, old-growth forests are only one stage in forest development and the biological diversity that is characteristic of the forests of a region is a product of all stages including early post-disturbance (open canopy), regeneration, canopy closure, and maturing stages of forest development.
6. Studies of natural disturbances and natural and semi-natural forests indicate that disturbances are often patchy, leaving biological legacies (structures and species that survive disturbance) that support ecological diversity at multiple spatial and temporal scales.
7. Forest management practices that more closely emulate patchy natural disturbances and forest dynamics can be an important component of managing forests for diverse values.
8. Forest reserves are an important part of any forest conservation strategy, however, reserves alone will not ensure long-term persistence of desired elements of native forest biological diversity for the following reasons:
    a. The total area and distribution of reserves may not be adequate because of past land-use practices or amount of land that society is willing to dedicate to dominant-use reserves.
    b. Reserve designation says nothing about forest condition, the forests in many reserves have been degraded by past uses and forest conditions, and species occurrences in reserves will change as a result of succession and disturbance or other processes.
    c. Areas outside of reserves—also called the matrix-- will typically occupy a large portion of a region and have a strong influence on biological diversity.
9. Conservation of biological diversity requires a multi-scale spatial perspective—from micro-sites to coupes to landscapes to regions—and a long-term temporal view—decades to at least a century.

In addition several lessons have been learned from the development of forest biodiversity policies including:

1. It is important for management agencies to develop operational indicators of biological diversity so that tradeoffs among uses can be understood and trends in the ecological condition of forests can be evaluated.
2. Given climate change, social changes and natural disturbances the values associated with forests and the conditions of forests will continue to change in the future—uncertainty is ever present, making monitoring, research and adaptive management central to forest conservation and management.

In the following sections I offer some observations and suggestions related to VR, landscape-level thinking, and research.

Variable Retention at the Coupe Level

1. **VR makes ecological sense in these forest types.** Studies of the ecology and dynamics of these forests indicate that the species and processes that occur here would have experienced patchy disturbances in the past under the current climate regime. These fire regimes would have been characterized by different ranges of intensities and frequencies. Consequently, the practice of VR should, in theory, retain some of the elements of native forest biodiversity associated with older forests.

2. **There is evidence that VR as it is being implemented will retain elements of old forest diversity compared with CBS silviculture.**
    a. Field observations of research and operational VR coupes indicate that coupes with VR retain important elements of structural diversity: Large live old trees that could provide nesting sites for animals including hollow-using species, large dead standing and fallen trees that provide habitat for vertebrates and invertebrates, understory rainforest species, microclimates that are buffered relative to open areas, and gaps and dense areas of vegetation that create a fine-grained mosaic of conditions.
    b. Early empirical results also indicate that some plant and animal species that are characteristic of older forests are retained in retention patches.
    c. Most of the area of the coupe is within the zone of influence (e.g. short distance seed dispersal) of older forest. One study has shown that some rainforest plant species can disperse over these distances into openings in a relatively short time period. The use of one-tree height as a guide for edge effects seems reasonable to me.
    d. Majority of the retention patches survived the logging and regeneration burns intact during the first couple of years. Monitoring of future trends is needed because the ecological benefits of VR are expected to run for many decades and change over time.
    e. Some surface fire has occurred within retention patches and this is not necessarily detrimental to the goals of VR. Historical wildfire in these forests would have burned with variable intensity. Guidelines should be developed, however, for the maximum area of retention patches that could experience fire.
    f. Some overstory trees in retention patches have been killed by fire. Again this is not inconsistent with the concept of VR. These trees should not be salvaged as they contribute to structural diversity.
3. **Experience thus far indicates that VR can be a practical management practice that meets safety and wood production goals. Some further development and adaptation to local conditions is needed, however.**
    a. Harvest safety standards apparently can be met through the leaving of aggregates rather than single trees. Some questions remain about whether aggregate boundaries need to be marked to meet biodiversity and regeneration fire goals. Such marking could increase risk to loggers if safety is not considered in the marking of the boundaries. It appears that the issue of marking and safety can be resolved as more experience is gained with the practice and different approaches are tried and evaluated.

b. My observations and discussions with managers indicate that regeneration goals can be met in most cases but that natural regeneration from standing trees may need to be supplemented by aerial sowing. Modeling to estimate landscape and long-term effects on wood production should be continued. Tradeoff analysis could be used to determine if the effort required to meet current stocking guides are worth the costs of additional management intensity.
c. I have concerns about the need and consequences for large fire breaks around the aggregates where heavy machinery is used to scrape a several meter wide track. The effectiveness is not clear and effects on soil biota and site productivity may not be desirable, especially given the high edge to area ratios in VR coupes. The issue of fuel breaks needs more evaluation and adaptive management.
d. It is not clear what the edge effects might be on the growth of the regenerated eucalypts. This needs to be evaluated and factored into the effects analysis. Lidar could be used to evaluate regeneration height across existing coupes.
e. It is not clear yet what the impact of browsing might be on regeneration and stand development. Given the proximity of forest cover to the regenerating area it is likely that losses of regeneration to browsing could be higher unless browsing animals are controlled for a few years until regeneration gets established.

4. **Don't forget dead wood within the coupe**. Large diameter pieces of dead wood on the forest floor provides habitat for many organisms. I did not see data on how much large diameter wood on the forest floor changed before and after the logging operation. It appeared that there were many large pieces left in the coupes that I saw but levels of dead wood should be evaluated and some guidelines for retention developed. Guidelines for retention of large pieces of dead wood would be especially important if fuel wood removal is practiced.

5. **It is important to maintain long-term research and monitoring on the research and operational VR coupes**. The ecological responses to VR will vary with time and geography. Consequently, it is important to maintain existing research studies and to establish monitoring of operational coupes across a range of site conditions. Research studies would be relatively comprehensive and intense and designed to help develop more streamlined and practical monitoring protocols.

6. **Don't forget the longer-term perspective on VR.** Much of the research and emphasis so far has been on the immediate effects of VR and its implementation. This is natural and justified but it can leave some with the impression that VR is all about carrying over the elements of biodiversity through a disturbance. In fact VR is also about creating forest structural variability that will provide habitat benefits throughout the management cycle. The presence of old forest patches within uniform young and mature stands may benefit some species directly and provides a source of

organisms that contributes to the long-term diversity of the entire coupe and surrounding landscape. These benefits can be illustrated through modeling and visualization products. It may also be possible to evaluate some of the longer-term benefits through retrospective research on areas that have experienced partial stand replacement disturbances in the past.

Summary. VR will provide tangible ecological benefits in terms of retaining older forest compositional elements and structures in coupes where it is applied. Compared with conventional CBS, these coupes will have significantly higher structural and compositional diversity than coupes where no remnant patches are retained. These benefits should increase over time, as late-successional species disperse into cut areas from remnant patches. As the regenerated eucalypt stands grow in stature the entire coupe should more rapidly move toward the structural and compositional diversity of the previous older forest than it would under a CBS system. Early results indicate that VR can be a practical approach to providing both late successional and timber values from the same area. Research and monitoring should be continued to evaluate the longer term consequences of this new silvicultural system and to modify management practices to insure that VR can also meet safety and economic goals.

The Landscape Level

It is important to develop operational measures of biodiversity conditions at multiple spatial scales. It appears that social pressures were the primary drivers of the decision to adopt VR and make other changes in forest practices such as stopping conversion of native forest to plantations of exotic species (which is a very positive step in the process to develop sustainable forest management practices). This is normal, however, development of a stronger scientific/ecological basis for VR practices can have several benefits including developing a greater understanding of effects and trends and greater ability to anticipate problems and make course corrections before options are precluded. In addition, the development of operational biodiversity performance measures can increase transparency of management and social understanding and acceptance. Forestry Tasmania efforts to develop these measures are well underway at the coupe level and this work should continue. At the landscape level, these efforts are only in their infancy and I would encourage further work in this area. The Montreal process indicators are a good start but these were intended for country-level comparisons and do not provide some of the key measures of condition that are needed at subregional scales. For example, forest structural elements such as number of hollow bearing trees, and landscape characteristics related to area of forest growth stages by ecoregion or edge density and patch size are not included. The following are some suggestions:

Develop a few key measures of biodiversity condition that can be scaled up. The management response to social concerns about native forests is primarily framed as a choice between establishment of reserves or stopping clearfelling on managed lands and practicing VR. By framing the management problem as an allocation or silvicultural practice issue, the impression may be given that that the two practices are not connected or are the goals in themselves, when in fact they contribute to the overall state of the forest environment and they are management tools intended to maintain elements of native forest biodiversity including structures, plants, fungi, vertebrates, invertebrates, and ecological processes, such as carbon sequestration or clean water production.

Metrics are needed to characterize biodiversity status and trends and improve accounting of biodiversity at multiple ecological scales: fine-filter (the occurrence of individual species or their habitat), meso filter (key forest structural characteristics such as large hollow-bearing trees) and coarse filter (vegetation types, landscape pattern metrics, or disturbance regimes metrics). Focal species can be a valuable part of a set of ecological metrics. Ideally some species (e.g. sensitive species) should be monitored directly through occurrence studies or population studies. This type of measure is useful to both establish the habitat needs of a species but also to detect trends in biodiversity that are not associated with habitat (e.g. competition, disease). In most cases, however, focal species are evaluated using modeling of populations and habitat. When using focal species it is important to select a range of species that represent different habitat needs (e.g. old and young forest, or small and large territories). It is also important to recognize that the focal species do not necessarily represent the needs of other species and processes—they are in essence example species that are a subsample of the set of native biodiversity. The specific habitat needs of some sensitive species can be modeled based on empirical data or expert opinion. More generally, structural elements can be scaled up from the coupe to the landscape including the number of hollow bearing trees, number of large trees, number of large pieces of dead wood and area. A few landscape level metrics should also be part of this set. These should be very carefully chosen, however, for relevance to known or hypothesized ecological processes (e.g. edge effects).

Develop some overall expected/desired trends in key indicators at the landscape level. One of the major challenges in implementing biodiversity practices is specifying the goals and outcomes at multiple scales**.** Without some sense of what the goals are or expected trends are, it is difficult to know when a management agency has done "enough" to provide for native biodiversity. Or, the tendency may be to extrapolate goals from particular coupe practices to the entire forest estate without considering landscape-level patterns and processes. For policy makers, the biodiversity goal post may be constantly moving—with each advance in biodiversity protection the goal seems to recede. Shifting goals are, of course part of the practice of natural resource management. However, without some goals and expected trends it is difficult to communicate accomplishments and anticipate problems. I could not find a clear statement of how Forestry Tasmania prioritizes its "triple-bottom line"—economic, social, and environmental. Are these all equal?

Political and management decisions made over recent years in Tasmania, however, have generally defined the overall balance that FT currently intends. For example, designations of reserves, establishment of an annual 300,000 m^3 eucalypt sawlog supply goal, and adopting VR in tall old-growth coupes have, in effect, established many of the current priorities of forest values from Tasmanian State forests. Given this context it would be desirable to determine how certain biodiversity conditions might change over time in the same way that trends in sources and volumes of wood are projected. Key measures could include—forest development stages (e.g. old growth) but also key forest structures and a few landscape metrics including area types by ecoregion, edge, and patch sizes. One observation I had was that there is around 20% of the native forest production areas that are set aside because of streams or non-suitable site conditions. These represent a landscape-level retention that contributes to biodiversity but is invisible if the focus is only on retention in coupes. VR coupes, informal reserves and other non-operational areas, formal reserves and managed native forests all contribute to native forest biodiversity in some way. Without this recognition, it may appear to some that native biodiversity only occurs in large formal reserves and some VR coupes. It is not clear to me how all of the FT allocations and practices add up to a total picture of biodiversity conditions and potential for FT lands. It may be that Forestry Tasmania is not getting full credit for the biodiversity values it is really producing. It may be that there are some gaps geographically in landscape and patch conditions that warrant changing the mix of conservation strategies. It may be that sometime in future a bottleneck or shortfall will occur in some desired forest value. Such analyses do not necessarily require a large investment. Through the use of surrogates and simple models some first approximations of landscape conditions and trends could be developed.

Research

I'm very impressed with the research staff and investment that FT has made. The published work is world class and given the management context, FT scientists have an opportunity to really advance our knowledge of how to conduct sustainable forestry where high ecological, social and economic values occur together.

Some suggestions:

Consider putting some long-term plots in older forests in Warra and other locations to track growth and mortality of older forests. Information from such studies could give FT a picture of the successional trends in older forests and provide information about carbon dynamics. FT is investing a considerable amount of land in old-growth forests, it would seem prudent to make some effort to evaluate and understand trends in those forests. These forest have high carbon sequestration potential and such information may be needed as carbon markets develop. Information about rates of succession and stand development could also be useful in assessing trends in forest conditions inside and outside reserves and in the rate of development of future old growth forest from young and mature forests.

Consider developing a more structurally based definition of old growth and/or structurally based characterization of stand development pathways for these forest types. This information could contribute to a characterization of biodiversity across all lands and help communicate the dynamic nature of these forests and the fact that old-growth is not a black and white issue—at least from an ecological perspective.

Consider developing some "cartoons" of how multi-coupe small landscapes will develop under VR and other retention practices. These can help communicate the contribution of VR over time and identify possible future problems.

Consider conducting a landscape analysis across all land tenures to help place FT lands in a continuum of forest management goals. This broader landscape analysis would presumably also point out that many of the most threatened elements of biodiversity in Tasmania are not associated with old forests but with drier open forests and non-forest types and that many of these are located off public lands.

Conduct some analyses of the benefits and costs of VR in regrowth stands. Current efforts in old-growth coupes are beneficial but may be rather limited at a landscape level. There certainly would be ecological benefits accrued from this practice in all coupes but the benefits would depend on the landscape context and the economic tradeoffs would need to be considered.

Emerging Issues and Opportunities

Carbon dynamics. The contribution of forests and forestry to carbon sequestration is getting increasing attention**.** Research is needed that explores how carbon dynamics vary under different management and policy scenarios (e.g. all reserve, current policy, manage more intensively). The research should also highlight the tradeoffs with other values.

Social interactions. Social science research that explores the role of society in forest policies and practices could help provide some context for the forestry debates. It would probably not change the minds of many stakeholders but it could help people to see the important social processes that characterize the Tasmanian forestry experience and perhaps expand the scope of the debate away from simple black and white thinking.

Thinning. Thinning will increase in importance. Research on the ecological, social and economic aspects of this practice would be valuable. Starting this work soon could produce this information when it is most needed in a few years. It also might be possible that thinning could be seen by some stakeholders as a practice that provides wood with little ecological impact or even positive benefits. This could help change the terms of the debate about logging in native forests.

Global interactions. It might be valuable for Forestry Tasmania to contract for some analyses that evaluate how Tasmania sits in a global context in terms of exports and imports and ecological and social consequences of Forestry Tasmania's practices at a global scale.