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Allowable Cut in Forest Management

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Introduction

Allowable cut is a guide used to regulate timber harvests in both plantation and natural forests. The concept is long-established, but it remains loosely defined as "the volume, number of stems, or area cut over, either annually or periodically" (Ford Robertson 1971). Over the years, various formulae and algorithms have been proposed to assist with the calculation of the allowable cut, but until recently the underlying tenet has not been seriously challenged. However, in recent time, the concept has been criticised on both economic and ecologic grounds, and alternatives have been offered.

The term 'allowable cut' is sometimes been used to denote the total quota allocated to log purchasers (e.g., Vanclay 1996a), but the present context is that of an evidence-based estimate of the harvest that can be sustained long-term, and not of a politically-convenient agreed harvest.

Concept

The underlying concept of allowable cut was recorded in Evelyn's (1664) book *Sylva*, in which he recorded (chapter 32, paragraph 13) that "*...in Germany and France … the King's Commissioners divide the woods and forests into eighty partitions, every year felling one of the divisions, so as no wood is felled in less than fourscore years. And when any one partition is to be cut down … every twenty foot leave a good, fair, sound and fruitful oak standing … the acorns which take root in a short time furnish all the wood again...*". This rather ancient advice remains the underlying basis for allowable cut, subject in this particular example to the caveat that regeneration is adequate and that trees grow to maturity in 80 years. The use of "fourscore years" in this example is not central to the concept, and merely reflects the anticipated time to maturity for the tree species and location in question.

In this example, an annual allowable cut has been defined for a naturally-regenerated forest, but the concept applies equally well to a plantation, uneven-aged or natural forest, and requires only that a sufficient interval (cf. 80 years) is allowed for the forest to recover sufficiently after harvesting. This example prescribes area regulation (with $1/80^{th}$ of the area harvested each year), but the concept applies equally to other quantities including numbers of trees and volume of wood. Vanclay *et al* (2006) offered a simple and practical exercise that illustrates the application of these variants in the context of tropical forests.

Strengths

The principal strength of the allowable cut is that it defines in a single indicator, the long-run average harvest that may be attainable from a forest. Although sustainable forestry is a complex and multi-facetted objective, this simple index may be one of the most useful guides for setting the recommended harvest. However, like all such indicators, it needs to be calculated correctly, applied thoughtfully and reviewed regularly. Nonetheless, many decades of use in far-flung and diverse forests have cemented and not detracted from its utility. The fact that it continues to receive regular mention in forest management texts (e.g., Buongiorno and Gilless 2003; Higman *et al* 2004; Bettinger *et al* 2009) attests to its utility.

A particularly robust approach is area control, in which harvesting regulated by setting the allowable cut in terms of the area available annually for harvesting. Leak (2011) advocated the following advantages of this approach:

1. *It is a low-cost and hands-on method that foresters and the public can readily understand.*
2. *The process can work with minimal inventory data, which can be collected as needed.*
3. *The results are spatially explicit and coordinated with the access plan.*
4. *The process forces a regular examination of the whole forest.*
5. *The system avoids the possibility of serious over-or under-cutting.*
6. *The approach is suitable for small to moderate holdings without extensive computer facilities and expertise other than perhaps a simple database system.*

Limitations

When the allowable cut is used as a guide in conjunction with other objectives and performance feedback, it has relatively few limitations. However, several problems may arise if attaining the allowable cut becomes the over-riding objective of forest management. For the purposes of discussion, it is useful to denote these hazards as estimation, ecologic and economic issues.

Estimates of the allowable cut may rely on several items of subordinate data, including evaluations of the area available for harvesting, the time for trees to mature, regeneration success, and the impact of natural disturbances (such as wildfires). There is often a tendency to take an optimistic view of these estimates, and although these biases may be small, they tend to accumulate and inflate the predicted allowable cut. Thus it is important that the elements contributing to the estimated allowable cut are evidence-based, and are monitored and revised periodically. Particular care is needed with area estimates to draw an appropriate distinction between gross and net area (i.e., that is accessible and productive; Vanclay 2000).

Natural ecological cycles also detract from the utility of the allowable cut when implemented as volume control, because the long-run average growth may not occur each year, and attempts to attain the allowable cut during lean years may cause stocks to fall below optimal and initiate negative feedback. The educational game FishBanks (Meadows 1992) draws on this phenomenon to demonstrate that fixed quotas, even when apparently sustainable, can quickly deplete stocks and trigger a downward spiral during lean years. Although FishBanks simulates ocean fisheries, the principles apply equally for forest management and reinforce the need for regular review of the allowable cut.

Strict implementation of an annual allowable cut also runs contrary to efficient economics, because it assumes that demand for wood remains constant, despite clear evidence of cycles in demand for lumber. One solution is to allow some year-to-year flexibility by setting a decadal allowable cut so that the annual harvest can rise and fall with consumer demand while remaining within the decadal prescription.

Derivation and Application

Estimates of the allowable cut all rely on variants of Evelyn's (1664) rule of thumb which apportions the total area (or anticipated mature volume) across the number of years expected for trees to mature.

However, many variations exist to accommodate variations in forest condition and in some cases, discount rates. Kovats (1962) examined a dozen formulae, including long-established classics such as Hundeshagen's (1826) method and Hanzlik's (1922) formula, and reported a two-fold difference in the predictions of allowable cut for the research forest at the University of British Colombia. Many of these formulae make rather sweeping assumptions for computational efficiency, and have fallen into disuse since computers have enabled linear programming (Curtis 1962; Garcia 1990) and simulation studies (Vanclay 1994; Vanclay 1996b) that are better able to inform decisions concerning the allowable cut.

In the absence of reliable growth data, it is prudent to use area control, and to heed the advice of Higman *et al* (2004) to set a conservative allowable cut initially, to monitor growth rates, keep records and revise the allowable cut as improved data become available, and to monitor post-harvest growth to inform decisions about subsequent harvests. Keenan *et al* (2011) documented many of the hazards of over-optimistic estimates of allowable cut in a data-poor tropical forest context. In contrast, where sufficient inventory and reliable growth models are available, yield scheduling (e.g., Vanclay 1994) offers greater insights about the opportunities and consequences of different levels and approaches to timber harvesting.

Critical to its success is the need for consistency in the application of the allowable cut, particularly with regard to gross and net areas and volumes. Thus if an allowable cut indicates gross areas allocated for area control, then forest managers must avoid prospecting for attractive stands and ensure that the area actually harvested does not approach the upper limit of gross area, typically by mapping the physical location of allocated 'cut blocks' (e.g., Higman *et al* 2004). Because of the difficulty of maintaining a uniform standard both when estimating and applying the allowable cut, it is generally preferable to use net area as the basis for area control (Vanclay 1992). Similarly, if the allowable cut denotes gross bole volume for volume control, then forest managers must monitor and record gross bole volume, not net log volumes to avoid overcutting.

Alternatives

Sustainable forest management requires much more than slavish implementation of an allowable cut; it embraces other more diverse objectives, and requires greater flexibility in harvest regulation particularly following disturbances such as fire or storm damage. Regulating harvests whilst accommodating these modern demands requires something more sophisticated than slavish implementation of a simple allowable cut. Two particular weaknesses of the allowable cut are that it makes no specific recognition of the optimal stand condition, and that the volume control form of allowable cut can lead to negative feedback that depletes the standing stock. It is likely that sustainable forest management can be better served by identifying an optimal stand structure and forest condition (Vanclay 2003), and by explicitly identifying a harvest volume and pattern that helps the forest converge towards this optimal condition. Whilst defining this optimal condition and identifying a convergent harvest regime is more challenging than a formulaic allowable cut, it will also contribute more towards better forest management.

Future

The classic formulaic allowable cut, particularly the area control variant (i.e., $1/n^{\text{th}}$ of the area), is likely to remain an important part of the forester's toolbox because of its simplicity and robustness, but it should remain a guide to be used in conjunction with other objectives and indicators. However, where sufficient information enable more sophisticated decision support, harvest planning is likely to rely increasingly on a desired endpoint (i.e., optimal stand structure and forest condition) rather than on an allowable cut aimed at a non-declining even flow.

References

Bettinger P, Boston K, Siry JP, Grebner DL (2009) *Forest Management and Planning*. Academic, Massachusetts, 331 pp. ISBN 9780123743046.

Buongiorno J, Gilless JK (2003) *Decision Methods for Forest Resource Management*. Academic, Massachusetts, 439 pp. ISBN 9780121413606.

Curtis FH (1962) Linear programming the management of a forest property. *Journal of Forestry* 60(9): 611–616.

Evelyn J (1664). *Sylva, Or, A Discourse of Forest-trees, and the Propagation of Timber in His Majesties Dominions*. The Royal Society of London.

Ford Robertson FC (1971). *Terminology of forest science, technology, practice and products*. Society of American Foresters.

Garcia O (1990) Linear programming and related approaches in forest planning. *New Zealand Journal of Forestry Science* 20(3):307-331.

Hanzlik EJ (1922) Determination of the annual cut on the sustained basis for virgin American forests. *Journal of Forestry* 20(6):611-626.

Higman S, Mayers J, Bass S, Judd N, Nussbaum R (2004) The Sustainable Forestry Handbook: A practical guide for tropical forest managers on implementing new standards, 2nd Ed. Earthscan, London. ISBN 9781844071180.

Hundeshagen JC (1826) Die Forstabschötzung auf neuen wissenschaftlichen Grundlagen. H Laupp, Tübingen.

Keenan RJ, Brack CL, Golman M, Vanclay JK (2011) A simple planning system for sustainable timber harvesting in Papua New Guinea. In: JC Fox, RJ Keenan, CL Brack and S Saulei (eds) Native forest management in Papua New Guinea: advances in assessment, modelling and decision-making. ACIAR Proceedings 135, pp. 176-184.

Kovats M (1962) A comparison of methods of determining the allowable cut on the University of British Colombia research forest, Haney BC. Master of Forestry Thesis, UBC, Canada.

Leak WB (2011) Estimating allowable-cut by area-scheduling. USDA Forest Service Research Note NRS-115.

Meadows D (1992) Fishbanks Ltd, Institute of Policy and Social Science Research, University of New Hampshire, Durham, NH.

Vanclay JK (1992) Before you begin your inventory. ITTO Tropical Forest Management Update 2(4):4-6.

Vanclay JK (1994) Sustainable timber harvesting: Simulation studies in the tropical rainforests of north Queensland. *Forest Ecology and Management* 69:299-320.

Vanclay JK (1996a) Lessons from the Queensland rainforests: Steps towards sustainability. *Journal of Sustainable Forestry* 3(2):1-27.

Vanclay JK (1996b) Estimating Sustainable Timber Production from Tropical Forests. CIFOR Working Paper No 11.

Vanclay JK (2000) On yield regulation for sustainable forestry, with examples from Queensland. In: HL Wright and D Alder (eds) Humid and semi-humid tropical yield regulation with minimal data. Oxford Forestry Institute, Occasional Papers 52, p. 85-90.

Vanclay JK (2003) Realizing opportunities in forest growth modelling. *Canadian Journal of Forest Research* 33(3): 536-541.

Vanclay JK, Keenan R, Gerrand A, Frakes I (2006) Beer bottle tops: a simple forest management game. *International Forestry Review* **8**(4):432-438.