Principles for Impact Analysis

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Introduction

The purpose of this paper is to present some principles for constructing resource analyses that examine the impacts associated with the various components of a proposed land use and management plan. The focus is on timber supply impacts, however, the principles should also apply to analysis of other resource values.

Principles for impact analyses

The following bullets present principles that should be considered when designing and undertaking impact analyses. Details on these recommendations are discussed further in the following sections.

- When assessing potential impacts on allowable annual cuts (AACs) and timber supply, harvest forecasts should follow principles of the Timber Supply Review regarding the initial level of the base case forecast (or base scenario), decline rates, drops below the long-term harvest level (LTHL), timing of achievement of the LTHL, and the magnitude of the LTHL relative to the theoretical maximum sustainable level.
- In most cases the base scenario will reflect land base, forest management and harvest flow assumptions developed in the most recent timber supply review (TSR) analysis. Where information or assumptions used to formulate a base scenario vary from those used in the recent TSR, the analysis should identify the variances and describe the related differences between base scenario and the TSR base case.
- Unless an evenflow harvest forecast was used in the most recent TSR as the basis of the AAC determination, it is recommended that an evenflow policy not be used for the impact analysis.
- Ideally, a combination of harvest forecasts and related summary information (i.e., changes in cumulative timber supply) with land base and inventory impacts should be documented as part of an impact analysis.
- At minimum, harvest forecasts and reports or tables showing land base and inventory changes associated with scenarios should be provided.
- If the base scenario does *not* involve a drop below the LTHL, impact scenarios should also not incorporate such a drop. If a choice is made to include a drop below the LTHL in an impact scenario, an alternative flow without a drop should be presented for the scenario. At a minimum in such cases, land base and inventory changes relative to the base scenario should be provided.
- An impact analysis should include information that will enable decision-makers to separately assess the impacts of the various relevant plan components (e.g., proposed protected areas, and forest management changes) and the interactions, such as offsetting effects, among them.
- To examine potential AAC impacts, separate impact analyses should be done for each management unit covered either entirely or in part by the plan, since AACs are determined for entire management units. The overall plan impact would be

the sum of management unit impacts. This would apply unless a very small portion of a management unit is covered by the plan, in which case, analysis of the entire management unit would be onerous. If desired, a management unit could be divided into plan and non-plan areas, with separate analyses completed for the two components.

- Where harvests are substantially below the AAC or short-term levels from a timber supply analysis, the actual harvest level should be determined for use in socio-economic assessments. Revenue and employment impacts are more closely linked to actual harvest levels than to the AAC and medium- or long-term timber supply. However, timber supply forecasts are still important for assessing the potential implications of proposed plans or policies on timber harvesting opportunities over all time frames.

Sources of impacts

In general, timber supply impacts result from changes in the availability of the timber inventory for harvest. Availability can be affected either by changes in the land base available for harvesting, or by management requirements to retain older forest or to limit the area of younger seral forest or recent disturbance.

The available inventory can be affected disproportionately by changes in land base. For instance, in a management unit with significant harvesting history, removal of an area covered entirely by old, high volume merchantable forest, will reduce the available inventory by a greater percentage than indicated simply by the total area.

Changes to forest management requirements on the harvestable land base can also change the available inventory. For example, application of a requirement for a minimum amount of mature or old forest cover in a wildlife habitat zone that is within the THLB may reduce timber availability by extending the period of time over which timber in the area may be harvested (i.e., effectively extending the harvest cycle or rotation). Conversely, decreasing the area subject to visual quality management, or applying less restrictive visual requirements may increase timber availability.

The purpose of an impact analysis is to provide information to decision makers on the components of a proposed plan that would affect timber supply and harvest levels. The most common information generated when assessing timber supply impacts is timber supply, or harvest, forecasts and impacts on the land base available for timber production and harvesting. Much of this paper therefore focuses on the types of harvest forecasts and land base summaries that assist impact analysis.

Harvest flow considerations in the Timber Supply Review

One of the more difficult and subjective decisions in a timber supply analysis is the choice of harvest flow pattern or flow over time. Figure 1 provides a few examples of potential harvest flow patterns. These examples display the various general patterns. Any number of harvest flow patterns could be possible depending on the current AAC, inventory conditions, forest management objectives and availability of new site productivity information.

Perhaps the most complex forecast pattern is the declining flow with a drop below the LTHL. Such forecasts involve decisions on the starting level, the length of time that level is maintained, the rate of decline, the degree to which the forecast may be below the

LTHL, the timing of the increase to the LTHL, and the LTHL. In the Timber Supply Review, the general principles associated with these elements are (see also Figure 1):

- Attempt to achieve the current AAC for as long as possible without causing severe and abrupt disruptions in timber supply.
- When necessary, reduce timber supply at a controlled rate, with the rate of decline normally limited to a maximum of 10 percent per decade.
- A medium-term drop below the LTHL may be contemplated only when necessary to maintain short-term timber supply levels and when the medium-term level is at least as high as the long-term productivity associated with unmanaged stands. The drop below the LTHL may be justified given the expectation that active forest management will increase long-term productivity above levels expected from unmanaged stands. In general and on average, managed stands demonstrate productivity from 20 to 35 percent higher than unmanaged natural stands. Site index adjustments may make the difference larger. Nevertheless, the smooth transition between the short, medium and long terms is preferable.
- A medium-term drop below the LTHL should last the minimum length of time, and the LTHL should be reached by the time harvests are forecast to come primarily from managed, regenerated stands.
- The LTHL should be close as possible to the maximum sustainable level given land base productivity and forest management requirements, and ensure that total growing stock on the THLB remains at reasonably constant level. Long-term timber supply should not be reduced to allow for higher levels in the short or medium term.

These considerations regarding harvest flow are important because to be relevant for evaluating potential AAC impacts, an analysis should be consistent with TSR principles to the extent possible. To maximize relevance, these principles should be applied when generating sensitivity or scenario analyses, as well as for the base scenario.

In BC, as part of the timber supply review, reported harvest forecasts are normally at the maximum level that results in a controlled flow of timber supply (no abrupt disruptions) and a constant level of timber growing stock over the long term. A very large number of harvest forecasts would be possible that either fall below the full timber supply potential of the area or involve disruptions and uncontrolled changes in supply over time.

In the TSR, harvest forecasts normally exclude estimates of unsalvaged losses (USLs), that is, volumes that are damaged or killed by fire, insects or disease, and not harvested and billed. Impact scenarios therefore should not include USLs. Including USLs can create confusion when attempting to use results to derive employment and revenue impacts, which require estimates of harvest volume, not of total timber supply.

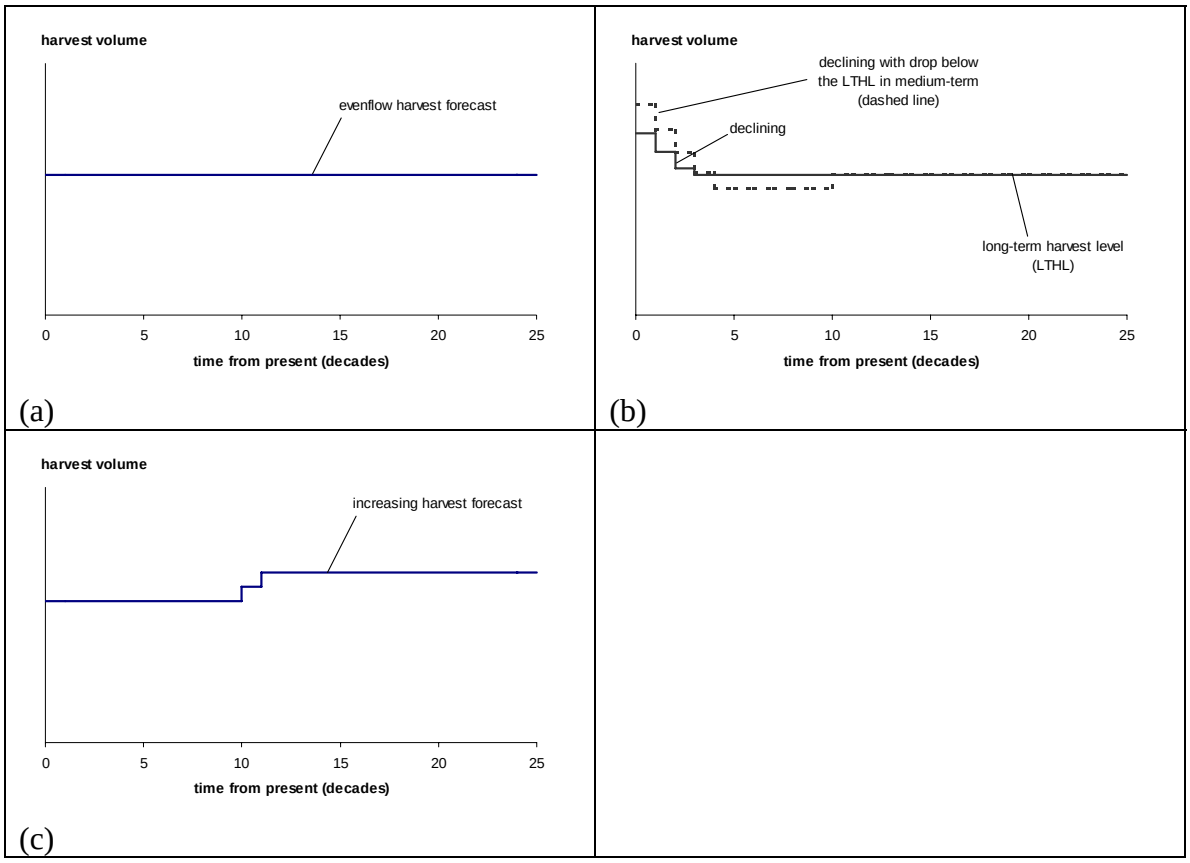

Figure 1: Alternative timber harvest forecasts: (a) evenflow, (b) declining and (c) increasing.

Evenflow forecasts are perhaps the simplest to use, since they avoid the complications of needing to define the pattern and rate of decline, and depth and length of a drop below the LTHL if one is necessary and justified. In the context of impact analysis, evenflow harvest flows might be a reasonable choice if only a general idea of the timber supply relationships among scenarios is desired. One shortcoming of evenflow forecasts is that it is not possible to discern the general limiting factor from the forecast. For example, a particular evenflow forecast could result because of a limit in the timber inventory available for harvest over the short and medium terms, or in the productive capacity of the land base. In rare cases, both factors could have equal effects. The outcome of an impact analysis, in which some land base or management inputs are changed to reflect a plan, will depend on the initial factor that defines the base scenario forecast. For instance, if the base scenario evenflow forecast is defined primarily by the productivity of the land base (the most common situation), any change in the size of the land base will result in a change in the evenflow harvest forecast, even if there is abundant inventory to buffer against short-term change. Conversely, a declining harvest forecast shows the maximum timber supply over each time frame (or should if it follows TSR criteria), and changes to inputs will result in timber supply impacts.

If the purpose of the analysis is to examine impacts on allowable annual cut (AAC), an evenflow flow policy would almost always overestimate impacts. Overestimation would occur because any change in land base or available inventory would change the

harvest forecast. In practice, the short-term timber supply may not need to be changed if there is an abundance of available inventory to buffer some downward influences. However, one of the most likely situations in which an AAC increase may be considered is if an evenflow forecast that is at or above the existing AAC can be increased over all time frames.

The shortcomings regarding the ability to determine the overall limiting factors associated with evenflow forecasts can to some extent be overcome by providing supporting information such as the change in land base and inventory associated with scenarios that examine different components of the plan or policy.

Overall, evenflow harvest forecasts, while relatively easy to employ in an analysis, frequently do not provide clear information on why a change has occurred, and may hide or magnify changes. As mentioned, additional area and inventory information can complement the harvest forecast and provide insight as to why an impact has occurred. However, unless an evenflow harvest forecast was used in the previous TSR, it is recommended that an evenflow not be used as the base scenario. If an evenflow forecast was used in the previous TSR, and adopted as a base scenario for impact analysis, an evenflow should not necessarily be applied in impact scenarios for reasons discussed above (e.g., it is difficult to assess timber supply dynamics with evenflow forecasts). Standard TSR flow principles should apply when developing impact scenarios.

Declining harvest flows are common in BC. They reflect timber supplies comprised of relatively high-volume old stands that can support higher harvest levels than projected for future managed stands[1]. As well, they reflect the desire for gradual transitions where current harvest levels are higher than long-term levels, to avoid introducing excessive economic instability. When declining harvest forecasts are necessary, the analyst must decide on the rate of decline, and potentially on the depth and length of a drop below the long-term harvest level. Normally there is an objective to maintain the initial level at the current AAC for as long as possible without causing abrupt timber supply disruptions or reductions to the long-term level.

With a declining flow, the impact of a change to the availability of the existing inventory and/or the timing of availability of second growth may be shifted to different time frames by using different flows (Figure 2).

[1] Although recent research on site productivity shows that long-term sustainable harvests may be substantially higher that previously estimated.

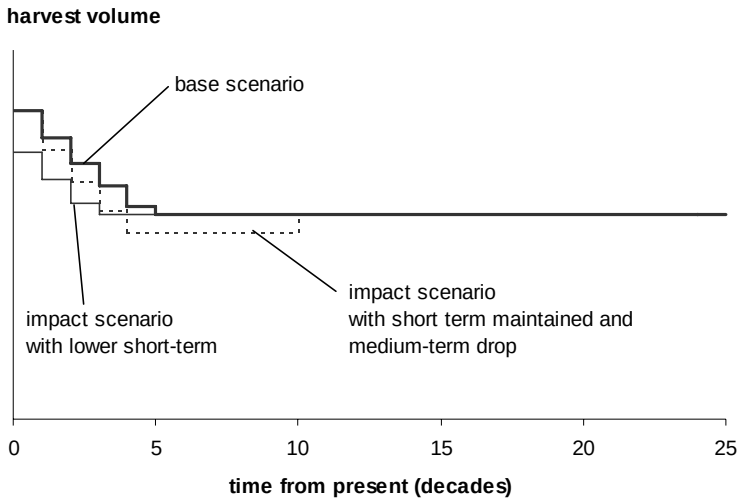

Figure 2 Harvest forecasts demonstrating two harvest flows applicable to the same impact scenario, one with an immediate reduction, the other with the short-term level maintained and a medium-term drop below the long-term level.

Increasing harvest flows (see Figure 1c) are not currently common in BC, but will likely become more common over the coming decades as harvesting shifts from predominantly old existing forests to managed forests. When impacts are measured against a base scenario with an increasing forecast, a medium-term drop should not be created. That is, the short- and medium term timber supply levels should be adjusted where required by the land base or management changes to maintain or enhance the stability in the harvest forecast shown in the base scenario.

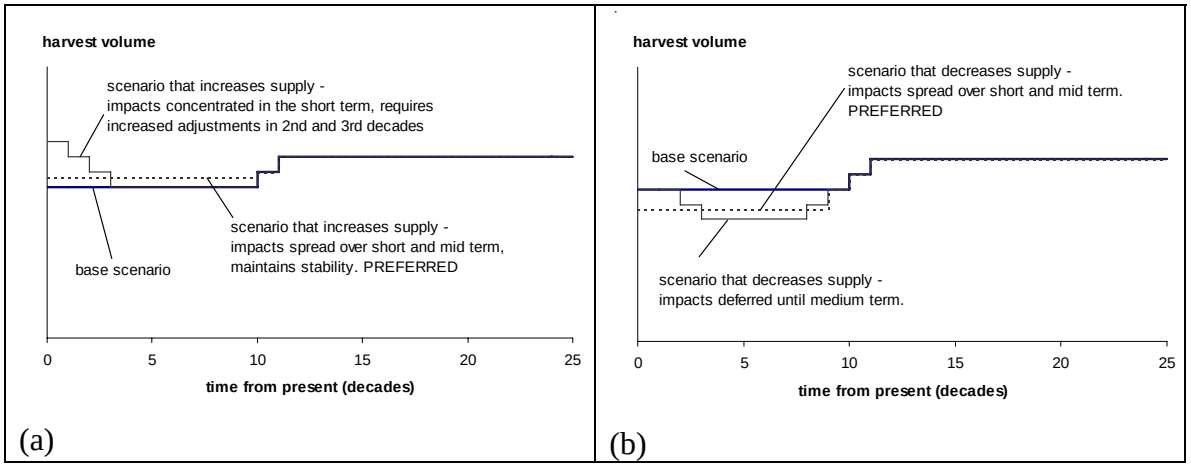

Figure 3 Hypothetical projections demonstrating issues associated with modelling impacts relative to increasing harvest forecasts.

The following points summarize the harvest flow issues:

- When assessing potential impacts on AACs, harvest forecasts should follow principles of the Timber Supply Review (TSR) regarding the initial level, decline

rates, drops below the long-term harvest level, timing of achievement of the LTHL, and the magnitude of the LTHL relative to the theoretical maximum sustainable level.[2]

- Avoid the use of evenflow forecasts, unless such a pattern would be generated based on TSR principles. Evenflow forecasts do not usually provide information on the causes of a change in timber supply (i.e., change in available inventory or in long-term productivity). Further, since they are not usually employed in TSR, they may result in larger changes to short-term timber supply than would be interpreted by the chief forester in an AAC determination.
- Information on the balance between short- and medium-term impacts is useful. For example, such information could be provided in harvest forecasts that show the implications of disallowing a medium-term drop below the LTHL compared to those that attempt to maintain the short-term timber supply at the currently allowable level.

Impacts of specific plan or policy components

Land use and management plans often involve a number of components that affect both the area that is available for timber harvesting, and the composition of the forest that must be retained in areas where harvesting is permitted. It is common practice when evaluating the impacts of a multifaceted plan to combine all land base and management changes into a single harvest forecast (see Figure 4).

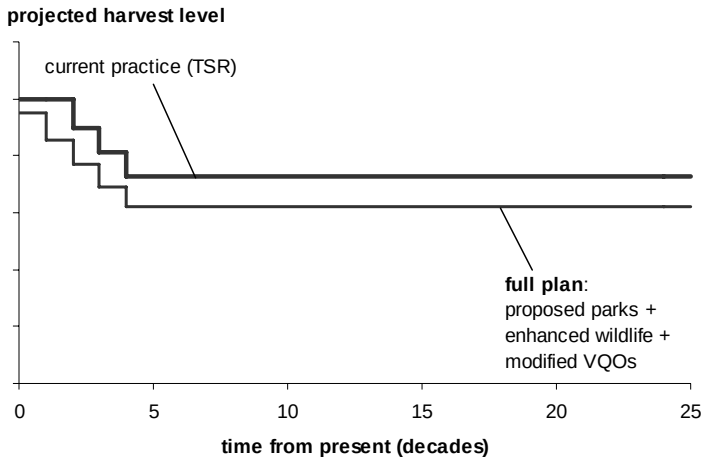

Figure 4 Hypothetical example of a harvest forecast showing the overall impacts of a plan.

[2] "Theoretical maximum sustainable level" is sometimes called the maximum sustained yield, and can be calculated by summing the products of the maximum mean annual increment (MAI) and area for each stand type ("analysis unit"). The LTHL in a harvest forecast, assuming it is a stable level, will always be less than the theoretical maximum because to achieve a constant harvest level some stands will not be harvested at their maximum MAI. Forest cover requirements and forest product objectives can result in further reductions in the LTHL relative to the theoretical maximum level. Further, short-term harvest levels could be elevated or maintained for longer at the expense of a lower long-term level. In determining the appropriate long-term level, care should be taken to avoid this latter situation.

In addition to the overall impacts, decision makers usually desire an understanding of how each component of a proposed plan affects timber supply. Figure 4 shows a series of harvest forecasts that demonstrate the impacts of the various components of a hypothetical plan. This example shows the incremental impacts of proposed management practices once proposed protected areas are excluded from the timber harvesting land base.

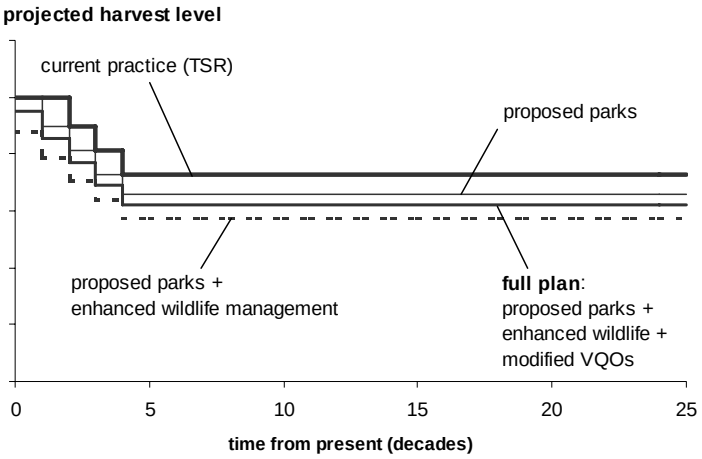

Figure 5. Harvest forecasts displaying the impacts of each component of a hypothetical plan

It is recommended that an impact analysis include information that will inform decision makers of the effects and interactions (e.g. offsetting impacts) of the various plan elements (see Figure 5). The forecasts in Figure 5 may incorporate overlapping impacts; for example, the impact of enhanced wildlife management on the current practice forecast may differ from the impact relative to the proposed parks forecast. If there is likely a great deal of overlap among plan components, it may be worthwhile assessing the impact of each component relative to current practice, in addition to the incremental approach demonstrated in Figure 5. Such an approach would provide decision makers with information on the impacts associated with each component as well as the interactions among the components, which could be useful when deciding about how different aspects will be incorporated into a final approved plan.

Care should be taken to distinguish between impacts attributable to the proposed plan or policy and those attributable to differences in modelling techniques. For example, if spatially explicit modelling of harvest blocks is included in an analysis of a plan, but was not included in the TSR, the difference between the plan and the TSR projections could be due partially or completely to the spatially explicit modelling. It is always tempting to incorporate new and improved modelling techniques. However, if the objective is to estimate employment and revenue impacts and compensation risk relative to the current timber supply levels, modelling techniques similar to those used in the most recent TSR are advisable. Adjustments are possible if different modelling methods are used, however, they can complicate the analysis. At a minimum, if modelling techniques different from the most recent TSR are employed in an impact analysis, the effects of the different approach should be made explicit.

Land base and inventory information

In addition to projections of changes to timber supply over time, information on the changes in the size of the land base and the standing inventory available for timber harvesting is important for assessing impacts (see Table 1).

Land base and inventory numbers are useful for interpreting harvest forecasts, and understanding the mechanism by which different scenarios affect timber supply. For example, a harvest forecast may show that it is possible to maintain the current AAC even after land is reserved from harvest in new parks. However, even though short-term timber supply may be maintained, the change in land status affects the available inventory, and hence the harvests that can be maintained over the medium term (next few decades). That is, maintenance of short-term harvests would involve the need to make compensating reductions in the future. In this case the lack of a short-term impact would result from flexibility in harvest flow, that is, the ability to decide on the timing of timber supply changes. An understanding of changes to land base and inventory that result from plan components can help the decision maker to understand the full timber-related opportunity costs of the plan.

Table 1: Land base and available timber for hypothetical scenarios relative to the base scenario

	Base Scenario	**Proposed parks**	**Parks + enhanced wildlife management**	**Full plan (parks, wildlife and VQOs)**
Productive forest area	150,000 ha (100%)	135,000 ha (90%)	118,000 ha (79%)	128,000 ha (85%)
Timber harvesting land base	100,000 ha (100%)	90,000 ha (90%)	78,700 ha (79%)	78,700 ha (79%)
THLB Timber inventory	10 million m^3 (100%)	9 million m^3 (90%)	8 million m^3 (80%)	8 million m^3 (80%)
Merchantable THLB Timber inventory	9 million m^3 (100%)	8 million m^3 (89%)	7 million m^3 (78%)	7 million m^3 (78%)
Available THLB Timber inventory	7 million m^3 (100%)	6.3 million m^3 (90%)	5.5 million m^3 (78%)	6 million m^3 (86%)

Another method of presenting information similar to changes in land base and inventory is to provide cumulative differences in timber supply for different time periods (Table 2).

Table 2: Cumulative timber supply for hypothetical scenarios relative to the base scenario

Time Period	Base Scenario	Proposed parks	Parks + enhanced wildlife management	Full plan (parks, wildlife and VQOs)
0 – 20 years (short term)*	100% (average 1 million m³/yr)	95%	83%	83%
0 – 100 years (medium term)	100% (average 900,000 m³/yr)	91%	80%	87%
101 – 250 years (long term)	100% (average 800,000 m³/yr)	90%	79%	86%

* The short term could also be defined as the first decade, depending on what factors define the timber supply forecast. The idea of including the first 20 years is that harvest flow choices can sometimes mask impacts. For example, a land base removal could be shown to have no first decade impact, but a large second decade impact. Such a situation would suggest that while it may be possible to remove the area with no immediate impact, the removal would likely present short-term operational difficulties. Conversely, a small impact over the first 20 years, with a larger impact over the medium term would indicate that there is enough flexibility to phase in or defer the impact of the land base removal rather than reduce harvests immediately. None of this commentary is meant to speculate on what a decision-maker would do in such cases. Rather the situations are presented as examples of why this type of information would help to understand the time frames over which impacts may be experienced.

Tables 1 and 2 demonstrate different methods for presenting impacts. They provide some overlapping and some distinct information. Ideally a combination of harvest forecasts and related summary information (e.g. as in Table 2) with land base and inventory impacts (Table 1) should be documented as part of an impact analysis. At a minimum, comparable harvest forecasts (e.g., Figure 4) should be provided. If a decrease below the LTHL is employed in any impact scenario and the base scenario does not, it would be preferable to present an alternative flow for the impact scenario that does not incorporate a decrease below the LTHL (e.g., Figure 2). At a minimum in such cases, land base and inventory changes should be provided.

Actual harvest levels

Timber supply analysis assesses the impact of a proposed land use and management plan on timber harvesting opportunities. However, in some cases actual harvest levels may be substantially below the allowable annual cut or the short-term level shown in a timber supply analysis. Impacts on revenue and employment are more closely linked to harvest levels than to the AAC and medium- or long-term timber supply. Therefore, in cases where harvests are substantially below the AAC, the actual harvest level should be determined for use in socio-economic assessments. Even in such cases, timber supply forecasts are still important for assessing the impacts of proposed plans on timber harvesting opportunities over all time frames.