Integrated Resource Management Plan
Arrowsmith Timber Supply Area

Harvest, Silviculture and Retention Strategy

V 4.6

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forest ecosystem solutions ltd.

B.A. Blackwell & Associates Ltd.

EcoLogic Research

Prepared for:

BC Ministry of Forests, Lands and Natural Resource Operations
Resource Practices Branch
PO Box 9513 Stn Prov Govt
Victoria, BC V8W 9C2

BRITISH COLUMBIA

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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Acknowledgements

The Resource Practices Branch (RPB) of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNR) commissioned this project. The project was completed by Forest Ecosystem Solutions Ltd. (Antti Makitalo) with B.A. Blackwell and Associates Ltd. (Jeff McWilliams) providing expert advice and direction in all aspects of silviculture, and Ecologic Research (Steve Wilson) providing facilitation for stakeholder meetings and expert advice in topics regarding habitat supply and biodiversity.

The overall provincial project coordination from FLNR was carried out by Paul Rehsler. Craig Wickland provided regional perspective and expertise in silviculture, Tracy Andrews was the lead representative of the South Island Natural Resource District and provided guidance from the district's perspective. Bryce Bancroft from Symmetree Consulting Group Ltd. provided general professional advice and coordination with other similar ongoing provincial projects.

The authors would like to acknowledge and thank the following individuals who participated in the Arrowsmith stake holder group meetings throughout this project and contributed to the completion of this project.

Table 1: Members of the Arrowsmith TSA IRMP stakeholder group

Name		**Organization**
Tracy	Andrews	South Island Natural Resource District
Bryce	Bancroft	Symmetree Consulting Group Ltd.
Mary	Bauto	South Island Natural Resource District
Dorthe	Jakobsen	Climate Change, West Coast Region
Gary	Johnsen	Toquaht First Nation
Ed	Korpela	Wildfire Management Branch
Joe	LeBlanc	Interfor
Steve	Lorimer	Cowichan Lake Community Forest Co-op
Hal	MacLean	Forest Analysis and Inventory Branch
Antti	Makitalo	Forest Ecosystem Solutions Ltd.
Ken	Matthews	Coulson Forest Products
Darryn	McConkey	Ecosystems, Habitat, West Coast Region
Jeff	McWilliams	B.A. Blackwell and Associates Ltd.
Erin	Moore	BC Timber Sales
Rhonda	Morris	South Island Natural Resource District
Rod	Negrave	Research, Silviculture, West Coast Region
Mark	Palmer	South Island Natural Resource District
Paul	Rehsler	Resource Practices Branch
Mike	Stalberg	Fish and Wildlife, West Coast Region
Michelle	Todd	Interfor
Craig	Wickland	Forest Stewardship Coast Area
Steve	Wilson	Ecologic Research
Stefan	Zeglen	Forest Health, Coast Area
Bill	Zinovich	Cumulative Effects, West Coast Region

In the course of the project, the several working groups were formed to facilitate work under specific topics. These groups are shown in Table 2.

Table 2: Arrowsmith TSA IRMP working groups

Silviculture Working Group		**Organization**
Joe	LeBlanc	Interfor
Jeff	McWilliams	B.A. Blackwell and Associates Ltd.
Mark	Palmer	South Island Natural Resource District
Michelle	Todd	Interfor
Craig	Wickland	Forest Stewardship Coast Area
Wildfire Working Group		
Jeff	McWilliams	B.A. Blackwell and Associates Ltd.
Mark	Palmer	South Island Natural Resource District
Craig	Wickland	Forest Stewardship Coast Area
Paul	Rehsler	Resource Practices Branch
Ed	Korpela	Wildfire Management Branch
Biodiversity Working Group		
Darryn	McConkey	Ecosystems, Habitat, West Coast Region
Steve	Wilson	Ecologic Research
Bill	Zinovich	Cumulative Effects, West Coast Region
First Nations Working Group		
Tracy	Andrews	South Island Natural Resource District
Woodshed Working Group		
Tracy	Andrews	South Island Natural Resource District
Antti	Makitalo	Forest Ecosystem Solutions Ltd.
Erin	Moore	BC Timber Sales
Michelle	Todd	Interfor

Executive Summary of the Integrated Resource Management Plan

Timber Supply	This analysis first built a dataset similar to the one constructed for the Arrowsmith TSA TSR. After benchmarking, the data set was modified by incorporating additional THLB netdowns and management objectives that reflect the goals and objectives of the IRMP. This IRMP Base Case has a THLB of 43,004 ha and predicts a harvest level of 275,000 m^3 per year for 190 years after which the harvest can be elevated to the long-term harvest level (LTHL) of 284,400 m^3 per year. The IRMP Selected Management Scenario was chosen as it improved both the long term timer supply and value of the future timber supply, while minimizing the impact on the short term timber supply The IRMP Selected Scenario harvest level is 3.1% lower than that of the IRMP Base Case until year 125, when the transition to the LTHL occurs. The IRMP Selected Scenario harvest level is predicted to be 8.2 % higher than that of the IRMP Base Case between years 126 and 190 (297,550 m^3 per year vs. 275,000 m^3 per year), and 4.6% higher in the long term (297,550 m^3 per year vs. 284,400 m^3 per year).	
Objective	Maintain or increase timber supply. Increase the value of future timber supply.	
General Strategy	Apply harvest and silviculture strategies to achieve objectives.	
Harvest Strategy	West	Over the next 10 years, approximately 69% of the harvest - on average 185,162 m^3 annually - should come from the West zone to achieve the IRMP Selected Scenario timber supply forecast. The remaining 31% of the harvest is to come from the East zone (approximately 81,460 m^3 annually). To ensure the timber flow assumptions are met, almost the entire harvest in the West zone over the next 10 years should come from age class 8 and 9 stands (99.9%). The majority of the West zone harvest in the next 10 years (56%) consists of western hemlock (Hw) or amabilis fir (Ba) species. The component of western redcedar (Cw) and yellow-cedar (Yc) species is predicted to be approximately 39%. Approximately 77% of the short-term harvest (10 years) in the West zone is predicted to come from stands where conventional harvest can be employed (ground based or, cable). For the harvest forecast to hold, the balance of the harvest in the West zone must come from helicopter operable stands. Of all the West zone helicopter operable stands to be harvested in the next 10 years, 55% are Cw / Yc dominated stands, while the remaining 38 % are Hw/ Ba dominated stands. Approximately 82 % of the West zone harvest over the next 10 years is predicted to come from four woodsheds: Toquart/Lucky (31.3%), Escalante (24.2%), Handy (15.2%) and Effingham (11.3%).
	East	Over the next 10 years, approximately 31% of the harvest - on average 81,460 m^3 annually - is expected to come from the East zone. The entire harvest in the East zone over the next 10 years should come from stands older than 60 years (100%). The majority of the East zone harvest (76%) is expected to be Douglas fir (Fd). The component of Hw and Cw are approximately 13% and 3% respectively. Almost the entire harvest (97%) in the East zone over the next 10 years is predicted to come from stands where conventional harvest can be employed (i.e., ground based or, cable). Approximately 67% of the East zone harvest over the next 10 years is predicted to come from three woodsheds: Mayo/Hillcrest (27.7%), Mt. Brenton (20.9%) and Holland (19.1%).

Major Silviculture Strategies	Timber Volume and Value Over Time	Intensive management for timber volume and value under this strategy is directed to the green and yellow silviculture zones (sites with best returns and lowest risks). The silviculture strategy for existing managed stands consists of fertilization of Fd dominated stands every 10 years after 30 years of age and spacing of young Cw plantations to favour Cw over Hw ingress. For future stands, the strategy includes planting Cw on most ecologically suitable sites in the West and portions of the East zone with higher densities and spacing to favour the Cw. For the drier portions of the East zone Fd will be the primary species planted. This strategy also promotes stumping and planting higher densities of mostly Fd on root rot sites in the East zone. In addition, future Fd stands are fertilized starting at age 30. The silviculture strategy sets an incremental silviculture target of 110 ha of fertilization per year for the first 5 years at the cost $55,000 per year (or about 550 ha once during this period). The fertilization program is set to increase to 146 ha per year in the second 5-year period starting 6 years from today (or about 730 ha once during this period). The annual costs are projected at $78,000 for years 6 to 10. The size of Fd fertilization program is forecast to climb modestly through the next 40 years and then stay relatively stable over the longer term. It is expected that fertilization treatments will occur periodically (e.g.: treatments every 5 years to capture synergies and reduce costs. Approximately 31 ha of young Cw spacing are scheduled annually for the first 5 years at the projected cost of $78,000 per annum. The spacing area is set to increase to 56 ha annually for years 6 to 10 at the cost of $140,000 per annum. Due to the increased Cw planting on sites which experience significant natural infill, over the longer term the amount of spacing of Cw stands could increase. Planting Cw on additional sites at an increased density of 1,200 stems per ha (sph) (versus 900 to 1000sph in the Base Case) results in approximately 164 ha and 85 ha of area with increased planting costs annually for years 1 to 5 and 6 to 10 respectively. This increase of 200 to 300 sph is estimated to increase planting costs by approximately $200 to 300 per ha. The predicted annual incremental planting costs for years 1 to 5 are $40,900 and $21,250 for years 6 to 10 (using an average of $250/ha). This strategy allocates $50,000 annually for surveys and studies in the next 10 years. These surveys and studies are necessary to support the planned fertilization and spacing programs and to assess the opportunities and risks associated with planting and developing more Cw-dominated stands. The studies will also be used to determine fire threat levels outside of the urban interface areas to help allocate funding for fire threat mitigation. The surveys within the urban interface area is likely funded by the Union of BC Municipalities (UBCM).
Fire Prevention Strategies	Treatment of High Fire Risk Stands in the Urban Interface	The strategy is to determine actual fire threat levels in the urban interface areas through field surveys and prescribe appropriate treatments. Treatments may focus on reducing the canopy bulk density, reducing the overall density of the stand, and /or reducing on-ground fuels. Potential treatments for existing stands are partial harvesting, juvenile spacing and pruning. All treatments should also include slash treatments to reduce short term hazard. Treatments to reduce fire risk within the urban interface will be carried out in accordance with community wildfire protection plans. Treatments to reduce fire risk were not modeled due to relatively low amount (hectares) of high threat (risk) polygons within the TSA. In case of new plantations, consideration should be given to using fire management stocking standards located at: https://www.for.gov.bc.ca/hfp/silviculture/Fire%20Management%20Stocking%20Standards%20Guidance%20%20Document%20March%202016.pdf

<table>
<tr><td>Silviculture Program</td><td>Annual Treatment Schedule</td><td>
Years 1-5
<table>
<tr><th rowspan="2">Treatment/Activity</th><th colspan="2">Years 1 to 5</th></tr>
<tr><th>Area (ha)</th><th>Annual Costs ($)</th></tr>
<tr><td>Surveys and Studies</td><td>n/a</td><td>$50,000</td></tr>
<tr><td>Fertilization</td><td>110 ha</td><td>$55,000</td></tr>
<tr><td>Spacing</td><td>31 ha</td><td>$78,000</td></tr>
<tr><td>Enhanced Cw planting</td><td>163 ha</td><td>$40,900</td></tr>
<tr><td>Total</td><td>304 ha</td><td>$223,900</td></tr>
</table>
Years 6-10
<table>
<tr><th rowspan="2">Treatment/Activity</th><th colspan="2">Years 6 to 10</th></tr>
<tr><th>Area (ha)</th><th>Annual Costs ($)</th></tr>
<tr><td>Surveys and Studies</td><td>n/a</td><td>$50,000</td></tr>
<tr><td>Fertilization</td><td>146 ha</td><td>$77,000</td></tr>
<tr><td>Spacing</td><td>56 ha</td><td>$140,000</td></tr>
<tr><td>Enhanced Cw planting</td><td>85 ha</td><td>$21,250</td></tr>
<tr><td>Total</td><td>287 ha</td><td>$288,250</td></tr>
</table>
</td></tr>
<tr><td rowspan="5">Outcomes</td><td>Timber Volume Flow Over Time</td><td>The IRMP Selected Scenario harvest forecast is 3.1% lower than the IRMP Base Case until year 125. The IRMP Selected Scenario harvest level is predicted to be 8.2 % higher than that of the IRMP Base Case between years 126 and 190 and 4.6% higher in the longer term.</td></tr>
<tr><td>Timber Quality</td><td>The slightly lower harvest level results in a lower average timber revenue of about $150,000 per year for the first 70 years when compared to the IRMP base case. After this there is a significant increase in timber revenue over time. The largest increase occurs from the year 70 forward (increase in average timber revenue of about $1,000,000 per year between 70 and 140 years and $2,000,000 per year from 141 to 210 years)</td></tr>
<tr><td>Footprint</td><td>Significantly less harvest area over time than in the IRMP Base Case.</td></tr>
<tr><td>Habitat Northern Goshawk</td><td>Northern goshawk (NOGO) forage habitat objectives can be met within the forage areas without timber supply impacts relative to the IRMP Base Case.</td></tr>
<tr><td>Marbled Murrelet</td><td>The timber supply impacts to meet the marbled murrelet (MAMU) habitat targets were small. MAMU habitat targets can be met mostly from the NHLB.</td></tr>
</table>

Colocation Opportunities	UWR	Approximately 655 ha of UWR do not currently overlap with any other THLB reductions in the Arrowsmith TSA. Colocation of the UWR with other constrained areas, particularly OGMAs may provide opportunities to increase the THLB.
	WHA	Approximately 507 ha of WHAs do not currently overlap with any other THLB reductions in the Arrowsmith TSA. Colocation of some WHAs with other constrained areas, particularly OGMAs, may provide opportunities to increase the THLB

1 Introduction

The Resource Practices Branch (RPB) of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNR) aims to develop a new management unit planning framework; the Integrated Resource Management Plan (IRMP). The IRMP is a sustainable forest management planning framework with the objective to integrate all aspects of landscape-level and operational planning for each Timber Supply Area (TSA).

The IRMP integrates Type 4 Silviculture Strategies with timber supply review (TSR) to reduce duplication and redundancies where possible by sharing inventories, management zones, analysis units, Timber Harvesting Land Base (THLB) definitions and management assumptions. It is expected that the IRMP process will improve the linkages to landscape level fire management, the Cumulative Effects Framework, the Forest and Range Evaluation Program's (FREP) multiple resource values assessments (MRVA) and other regional, management unit level or landscape level plans and strategies.

This project in the Arrowsmith TSA is a pilot project and it has been completed in conjunction with the on-going TSR.

2 Context

This document is the fourth of four documents that make up an IRMP. The documents are:

1 Situation Analysis – describes in general terms the current situation for the unit. The Situation Analysis forms the starting point for the initial planning group meeting to identify opportunities.

2 Data Package - describes the information that is material to the analysis including data inputs and assumptions.

3 Modeling and Analysis report –provides modeling outputs and rationale for choosing an IRMP Selected Scenario.

4 Integrated Resource Management Plan – represents the IRMP Selected management scenario which is the basis for the first iteration of the IRMP. It includes an investment strategy and provides treatment options, associated targets, timeframes and expected benefits.

When the IRMP is complete, a spatial operations schedule will provide direction for harvesting and a land base investment schedule will guide Forest for Tomorrow (FFT) Annual Operating Plans.

3 Study Area

The Arrowsmith TSA is located on the southern half of Vancouver Island (Figure 1). It includes communities in four regional districts: the Alberni Clayoquot, Cowichan Valley, Nanaimo, and Capital

Regional District. Other major population centres include Duncan, Ladysmith, Municipality of North Cowichan, Parksville, Qualicum Beach and Port Alberni; smaller communities include Tofino, Ucluelet, Lake Cowichan, Nanoose, Chemainus, Union Bay and Fanny Bay.

The Arrowsmith TSA is part of the West Coast Natural Resource Region of FLNR and is administered by the South Island Natural Resource District.

The Crown land within the TSA is scattered with small parcels occurring along the east coast of Vancouver Island and along the west coast of Vancouver Island to Mooyah Bay in the north. The total area of Crown land is 159,214 ha, of which 4,127 ha is within the Tree Farm License (TFL) 46 takeback area. Figure 1 shows the Crown ownership areas within the TSA.

The TSA is divided into 3 zones: East, West and Clayoquot. The East zone has a long harvest history with extensive areas of managed second growth forests. Forests in the East zone are located near communities and often form community interface areas.

The forests in the West zone are generally older and more isolated; while second - growth forests, where they exist, are young and will not be available for harvest for some time. In the Clayoquot zone, timber harvesting and resource management is strictly governed as discussed below. The management zones are shown in Figure 2.

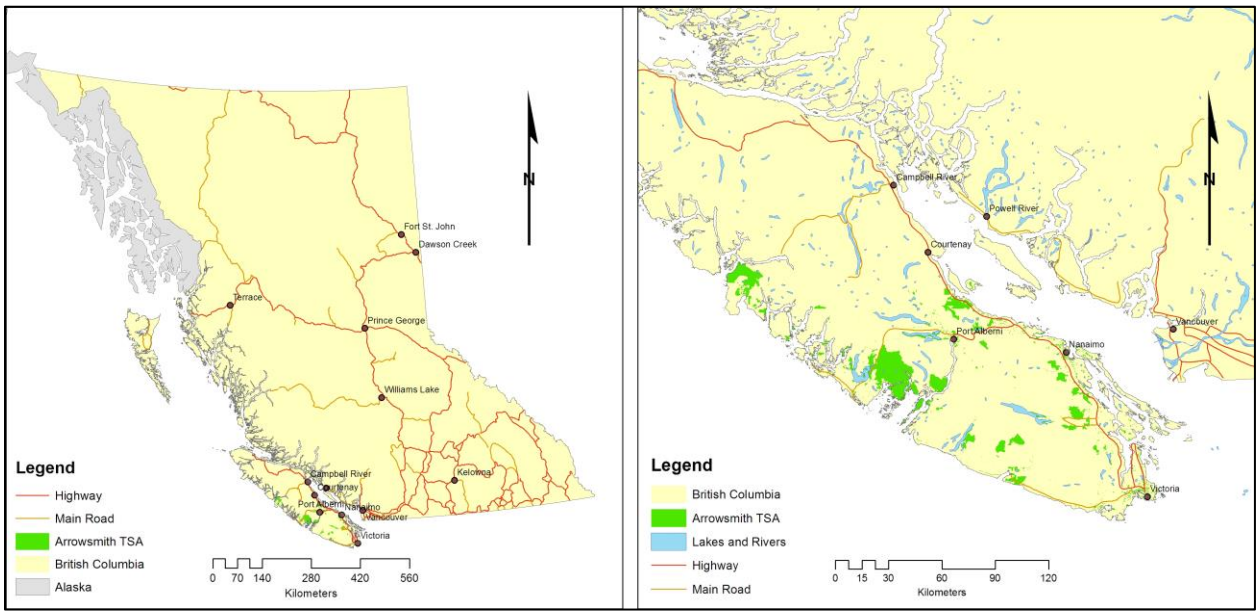

Figure 1: Location of Arrowsmith TSA

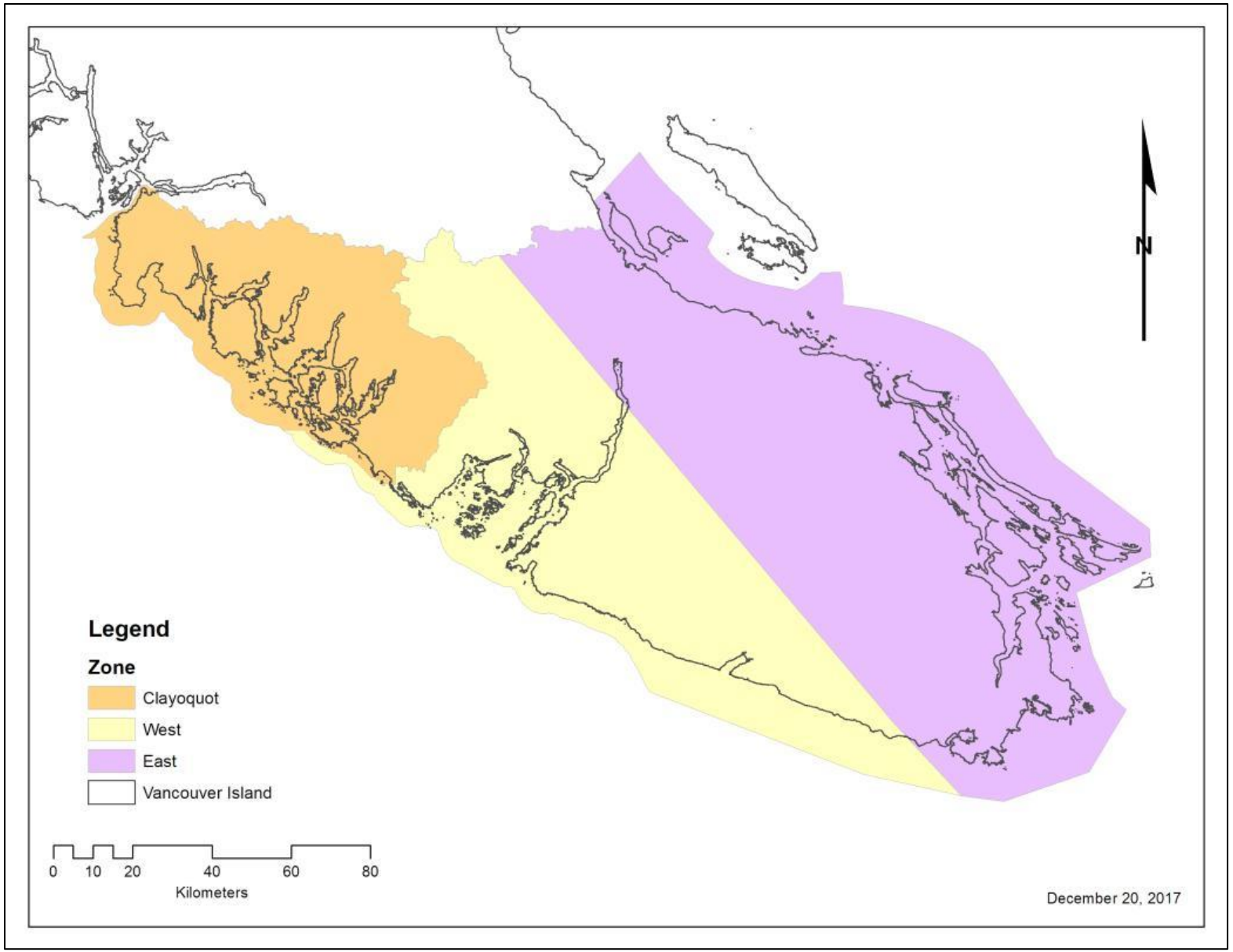

Figure 2: Arrowsmith TSA management zones

4 Critical Issues

Critical issues were identified during several stakeholder group meetings. The most important critical issues are listed below. It was understood that many of the critical issues could not be solved through this planning process; however, it was considered important to identify them in this report.

4.1 Characterizing of Current Management

The Chief Forester of British Columbia (BC) determines the allowable annual cut (AAC) for all management units in BC. The AAC determination process is guided by provincial laws and policy with the emphasis on accounting for current and reasonably expected management. The Chief Forester rarely speculates about land use decisions and only approved and implemented plans are incorporated into timber supply reviews with uncertainties tested through sensitivity analyses.

The Arrowsmith IRMP stakeholder group decided to incorporate impending land use decisions and voluntary deferrals in this analysis. In addition, the stakeholder group discussed impacts of constraints, and logistical and economic issues, which are often not fully accounted for in timber supply reviews.

4.1.1 Constraints Related to the Land Base

The Arrowsmith TSA is scattered throughout southern Vancouver Island and consists of many small parcels of land. Often adjacent lands are within different forestry tenures such tree farm licenses, woodlots or community forests, or are private forest land. Many areas are close to urban settings and/or are of interest to First Nations. This situation creates challenges for determining the available timber supply.

4.1.1.1 Legal and non-legal constraints and deferrals

The stakeholder group felt that the accounting for forest cover constraints such as cutblock adjacency, visually effective green-up and wildlife tree retention may not be adequate in timber supply analyses. These types of constraints often require forest cover retention and rate of cut control. It can be difficult to efficiently harvest remaining, adjacent timber after the initial harvest. Further, the scale and distribution of stand level retention is not well understood. Better reporting and monitoring of stand level retention would contribute to more accurate analysis of the impacts of management to meet these objectives.

Areas around Northern Goshawk (NOGO) nests may not be available for harvest for years without being reserved within a WHA or otherwise excluded from the THLB. Harvesting deferrals to protect these nests are also not specifically accounted for in timber supply reviews.

Voluntary deferrals are not included as THLB net downs; however these areas are excluded from planned harvest for short to long periods or permanently. For example, many areas in the Arrowsmith TSA THLB are within community interface or First Nations interest areas. While these areas contribute to the AAC, they may not truly be entirely or partially available for harvesting due to public and First Nations concerns. These deferrals can effectively reduce the area available for harvest or significantly delay the harvest.

A fragmented and constrained land base increases the probability of harvest deferrals of otherwise economically harvestable timber. Where significant investments in road building are required, it is

necessary for the short - term harvest volumes or values to be high enough to cover the amortized access costs. If there is not enough available timber for harvest in the short term, the harvest may have to be deferred until currently immature timber becomes merchantable and can be added to the pool of harvestable timber. At times these stands maybe isolated permanently.

Currently, timber supply review does not account for these types of deferrals. There is a need to consider temporary and permanent harvest deferrals in some areas where age class, species distribution, constraints and costs limit development.

4.1.1.2 Emerging Constraints

Strategic decisions regarding and NOGO and marbled murrelet (MAMU) are expected to further reduce the THLB. It is important to create clear objectives for the management of these and other wildlife species and understand the timber impacts of different options while providing the habitat elements seen as necessary. Colocation opportunities should be investigated.

Completion of existing, enabled processes such as the OGMA placement and Integrated Wildlife Management Strategy (IWMS) will reduce uncertainty with respect to impacts on the THLB.

4.1.2 Tenure and Appraisal Systems

4.1.2.1 Cutblock Blending Rules

Cutblock blending rules, as specified in the Coast Appraisal Manual, govern which cutblocks can be included in a given cutting permit (CP). This in turn determines the stumpage rate payable to the Crown by the licensee. A cutblock in a given area may not be economic to harvest. Combining this block with others under the same CP may allow for its economic harvest. Cutblock blending rules prevent cutblock blending in most cases for timber sale licenses (TSL).

BCTS has operating areas on southern Vancouver Island belonging to both Arrowsmith and Pacific TSAs. At times combining cutblocks from each of the TSAs into one timber sale would make an otherwise uneconomic timber sale possible. However; the current appraisal policy prevents blending cutblocks from different TSAs into one CP.

4.1.2.2 Impediments to Long term Value Creation

Harvesting rights within TSAs are primarily allocated using volume-based tenure agreements. These tenures have long terms and they are renewable. However, there is no guarantee that a licensee who harvests and reforests a site according to government regulated stocking standards will be able to harvest the regenerated stand. As a result, these tenures do not provide a framework that promotes the licensees to strive and exceed stocking standards in their reforestation. This is especially true if the preferred performance (stocking and species) is more costly. This is a problem, as most long - term strategies that are designed to improve volume and value commonly depend on investments in enhanced reforestation.

Under the current appraisal system major licensees (holders of renewable, long term volume and area based tenures) pay stumpage to the government to harvest timber. Simplistically, stumpage is the residual of the estimated value of the standing timber less agreed upon estimates of historical costs to access, harvest and transport the timber to market, and the costs to administer the license and reforest the harvested area as per the current stocking standards. The appraisal system provides little incentive for licensees to make investments in enhanced reforestation, as the licensee typically bears the extra silviculture cost in the short term and the government gets the majority of the increase in value through

higher stumpage when stand is eventually logged. This happens even if the licensee who reforests the site gets to log it again.

The appraisal system in its current configuration is an impediment to implementation of strategies that improve the long term timber value, such as those that have been outlined in the IRMP Selected Management Scenario and in this strategy. On many sites in the West zone of the Arrowsmith TSA, it is ecologically suitable and consistent with the stocking standards to reforest harvested stands with Fd, Hw or Cw (or combinations). At current log prices, successful reforestation with primarily Cw will result in a significantly more valuable stand than using either Fd or Hw.

While a Cw reforestation strategy is likely to produce a more valuable stand for a licensee to harvest in the future, the main beneficiary of the increased value will be the government as the recipient of significantly higher stumpage. On the other hand, the licensee potentially has to deal with higher costs and risks associated with planting Cw due to ungulate browse, and brush and Hw competition. This short term cost impediment can get more problematic, if the preferred Cw strategy is based on planting higher densities than are required by the current stocking standards.

In summary, many value strategies, such as the IRMP Selected Management Scenario for the Arrowsmith IRMP are based on investments in enhanced reforestation. However, the current tenure and stumpage systems do not provide an adequate incentive for licensees to make these investments on TSA lands. As a result, these strategies are difficult to implement without targeted changes to regulations, and the tenure and stumpage system, or by direct government funding mechanisms.

4.1.2.3 Growth and Yield

The stakeholder group agreed that our current knowledge of the growth and yield of managed stands and especially mixed species stands is lacking. The growth and yield, and health of existing managed stands need to be monitored or assessed. Data and information collected through mid-rotation stand monitoring should be used to inform growth and yield models and improve timber supply forecasts for future managed stands.

4.1.2.4 Timber Quality

The current provincial target for premium logs is 10% of the AAC for each TSA. In the past, a premium log was frequently defined by such characteristics as: species, taper (lack of), tightness of grain, clear wood, and size and diameter. Today many of the above-listed traits still signify quality; however, size alone tends to be less important.

It is not always clear whether the quality of managed stands is as expected. Furthermore, the quality expectations are often not defined. Data and information collected through mid-rotation stand monitoring discussed above should also be used to inform on the quality aspects of managed stands.

This strategy promotes the idea of higher establishment densities, especially for Cw plantations, to encourage the production higher quality trees with fewer, smaller branches and less stem taper.

4.1.2.5 Mid-Term versus Long-Term Timber Supply Trade-Offs

There is a concern over the harvest of young stands – significantly younger than their culmination age - in many coastal management units. The following issues were discussed at the stakeholder meetings of the Arrowsmith IRMP:

- What are the mid and long-term implications of harvesting 2nd growth stands as per current trends, where many young stands are harvested before their culmination age particularly in the East zone?

  A sensitivity analyses tested the impact of setting a high harvest priority on stands younger than 61 years old for both the East zone and the West zone. The timber supply was reduced by 9.2% for the first 85 years compared to the IRMP Base Case.

- What are the mid and long-term implications of not harvesting the older high elevation hemlock – balsam stands in the West zone?

  This was tested in the most recent TSR. Excluding the high elevation hemlock - balsam stands from harvest would reduce the timber supply over the first 10 years of the planning horizon by 6.6 percent. Mid- and long-term timber supply decreased by 1.5 percent and 1.2 percent respectively.

- Do we have the tools to control the age or location of harvest if we wanted to? If not, what policy or regulatory changes are required?

  The current legislation and policies do not allow the Crown to control the age or location of the prospective harvest, providing that the proposed CP application is consistent with existing legislation and policies.

- Do the licensees within the TSA have real choices, i.e. is some of the timber that is expected to be harvested uneconomic to harvest?

- What are the implications of harvesting young stands on biodiversity and habitat?

- What are the implications of harvesting young stands on investments made to improve timber quality?

  In some cases, the Crown has made significant investments to improve the quantity and quality of timber through silviculture treatments. The benefits of these investments are expected to occur only, if the stand is harvested later than comparable untreated stands. Investments are lost, if these stands are harvested too early.

5 Strategic Objectives

5.1 Working Targets

Provincial timber management goals and objectives include working targets for the provincial timber supply. The provincial goals and objectives in turn provide direction to all the TSAs. The stakeholder group did not set specific targets for the Arrowsmith TSA. Rather, the objectives were stated more generically as shown in Table 3.

Table 3: Management objectives for the Arrowsmith TSA

Value category	Objective	Performance measure/indicator	What is better?	Notes
Economic	Maximize volume harvested	Cubic meters harvested per year	More	This could be an aggregate over many years to allow year-to-year variation; this objective will be constrained by the even flow objective
	Maintain an even flow of harvested volume	Variance in annual volume harvested, by decade	Less	
	Maximize revenue of harvest	Yield times average revenue, by product and grades, summed by year	More	Using current log prices. Only for managed stands.
	Maximize carbon storage	Tonnes of carbon	More	A clear trade-off with harvesting but still an off-setting economic opportunity.
Environmental	Maintain Northern Goshawk nesting and foraging habitat	Known and modelled breeding territories	More	Does not directly address breeding areas, but locations are difficult and not as constraining as foraging requirements
		Forage habitat within home ranges in a suitable condition	More	
	Maintain CDF BEC zone representation	Area of CDF BEC zone reserved	More	
	Visuals	Overlap with other values	More	
	Maintain Marbled Murrelet Habitat	Suitable nesting habitat reserved	More	
	Maintain integrity of hydro-riparian network	Riparian habitat reserved	More	

Value category	Objective	Performance measure/indicator	What is better?	Notes
	for habitat, water quality and flow			
Social	Maximize availability of Cw for traditional use	Proportion of area of stands with >30% western Cw in age class 9+	More	
	Minimize risk of catastrophic fire in interface areas	Proportion of interface area classified as moderate-high threat	Less	

6 IRMP Base Case Analysis Assumptions

The Arrowsmith TSA timber supply review (TSR) Base Case analysis assumptions were revised through stakeholder meetings to reflect current management in the Arrowsmith TSA. Current management in this context accounted for imminent land base changes. While no changes are expected in the management of the Clayoquot Sound zone, it was removed from the analysis, because of the limited harvesting that currently occurs there. Table 4 shows those IRMP Base Case assumptions where they deviated from the TSR Base Case.

Table 4: IRMP Base Case assumptions

Objectives and overall assumptions	**Characterize current management to the extent practicable**
Land base assumptions	➢ Incorporate proposed area based tenures in the analysis; ➢ Remove Ditidaht red zone from the THLB; ➢ Exclude Clayoquot Sound from the analysis; ➢ Incorporate proposed NOGO WHAs and nests currently outside of WHAs in the analysis; ➢ Incorporate woodshed[1] volume targets, woodshed based NOGO restrictions and woodshed based harvest deferrals in the analysis.
Harvest assumptions	➢ Attempt to harvest 100,000 m^3/year on average from the East zone; ➢ Use oldest first harvest rule in the West zone.
Silviculture assumptions	➢ Use revised managed stand yield curves (TASS); include impacts of past spacing and fertilization; ➢ Incorporate shading effect as in TSR.
Habitat assumptions	➢ Report on NOGO forage habitat; ➢ Report on MAMU habitat.

The additional land base reductions and excluding the Clayoquot Sound zone from the analysis reduced the THLB from 65,433 to 43,004 ha. Further information regarding the IRMP Base Case analysis assumptions can be found in the Arrowsmith TSA Integrated Resource Management Plan Data Package (FESL, 2017). The complete analysis results are described in detail in the Modelling and Analysis Report (FESL, 2017).

[1] See Section 6.1

6.1 Woodsheds

Minimum volume requirements can be set for an area, when it is known that the financial viability of the harvest from that area requires a minimum harvestable volume. Due to the scattered and isolated nature of the TSA, some areas may require a minimum harvest volume to reflect the operational reality associated with mobilization and demobilization. Some TSA areas were subject to minimum volume requirements. These areas are referred to as woodsheds in this analysis. Woodsheds are illustrated in Figure 3.

7 Management Scenario Overview

The THLB in the Arrowsmith TSA was zoned to direct management intensity. Three zones were developed: green, yellow and red. Green depicts areas where investments in incremental silviculture are the most recommended due to higher site productivity, lower harvest costs, few constraints on future harvest and lower anticipated risk of investment loss. In the yellow zone caution is recommended, while the red zone denotes areas where incremental silviculture investments for timber should be avoided due to higher constraints, costs and risks. The THLB areas for green and yellow zones are presented Table 5 while the details of the zoning criteria are shown in Table 6. The silviculture zones are illustrated spatially in Figure 4.

Table 5: Silviculture zone areas

Silviculture Zone	Description[2]	THLB (ha)
Green	EM Contemporary	114
Green	EM Old	260
Green	Natural	369
Yellow	EM Contemporary	7,113
Yellow	EM Old	5,616
Yellow	Natural	10,019
Total		**23,491**

[2]Stands established prior to 1950 are considered natural stands (Natural).
Stands established between 1950 and 1985 are considered old plantations (EM Old).
Stands established 1986 onwards are considered contemporary plantations (EM Contemporary).
Stands originating from area harvested after 2015 are future managed stands.

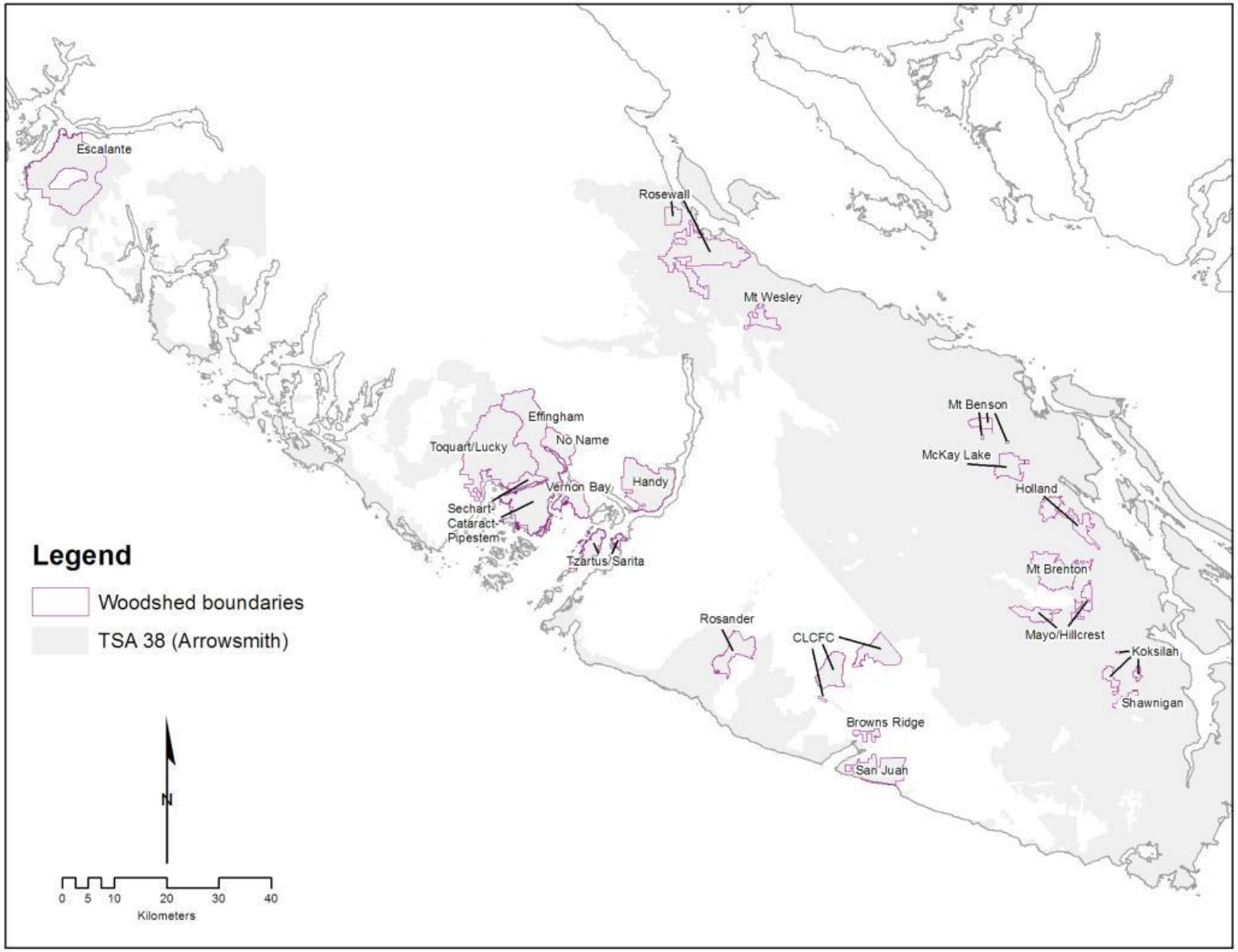

Figure 3: Arrowsmith TSA woodsheds

Table 6: THLB zoning, Arrowsmith TSA

Category	Data Source	Green (good)	Yellow (caution)	Red (stop)
Site Productivity, East	Lead Species, Site Class for Future Managed Stands	Fd good HB good	Cw good Fd med Fd poor HB med Ss good Dr med	Other
Site Productivity, West	Lead Species, Site Class for Future Managed Stands	Fd good Fd med HB good Ss good Ss med Dr med	Cw good Fd poor HB med Pl med	Other
Costs	Operability	Ground	Cable	Heli
	By woodshed, based on stakeholder information	Truck	Boom or Barge	N/A
Constraints to Harvest	FN interest areas, based on comments in woodshed analysis		yes	
	VQO	Other	PR	P, R
	Community Watersheds	No	Yes	N/A
	UWR	No	Partial harvest zone	No harvest zone
	NOGO	No	Forage areas	Nesting areas
	Draft OGMA (from licensees)	No	N/A	Yes
	CDF BEC zone	No	N/A	Yes
Other Constraints/Values	Elk hazard for reforestation; by woodsheds based on analysis of current and target populations	Low	Mod	High
	Fire Hazard	Low	Mod	High

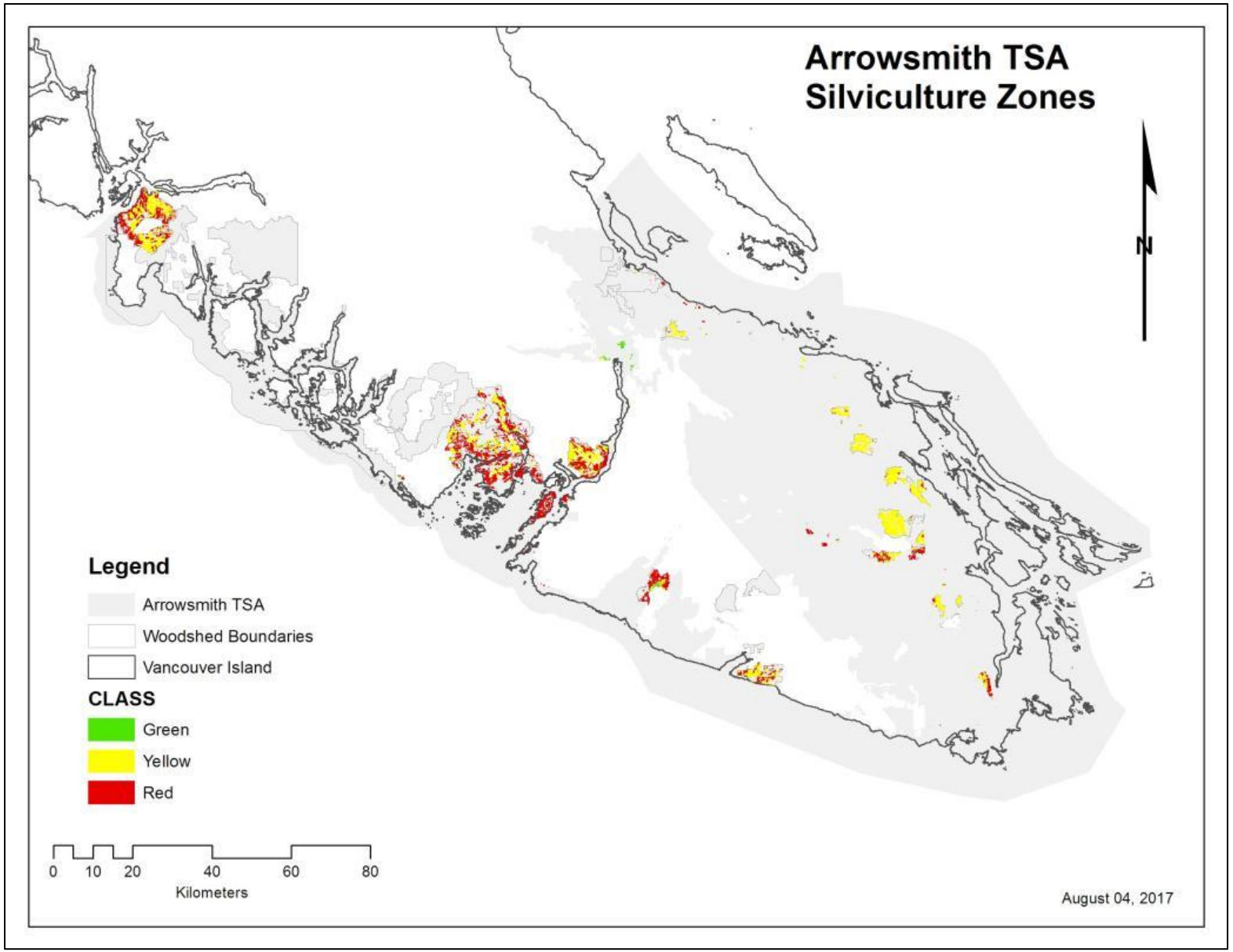

Figure 4: Silviculture zones in the Arrowsmith TSA

The following strategies were explored in this analysis:

Table 7: Management Scenario summary

Type	Scenario	Description
IRMP Base Case		Current practice, best available information
Strategies	Volume strategy 1	Treat existing and future managed stands to maximize volume; minimum harvest criteria 350 m^3 per ha in conventional harvest areas and at 450 m^3 per ha in helicopter harvest areas Existing managed stands: fertilize existing managed Fd stands at ages 30, 40, 50, 60 and 70 on good and medium sites 10+ years before harvest. Future stands: where ecologically suitable, plant hi-gain genetically improved Hw (GW=20%) instead of Cw or Fd. On potential root rot sites in the East zone complete stumping and plant a higher density of a mix of mostly Fd with some Pw. Fertilize future Fd stands on good and medium sites at ages 30, 40, 50, 60 and 70 10+ years before harvest.
	Volume Strategy 2	Same as volume strategy 1 except minimum harvest criteria set at age where 95% of the mean annual increment (MAI) culmination is achieved for each managed stand yield curve
	Volume Strategy 3	Relax VQOs by one class to simulate impact of partial harvesting As a surrogate to model partial cutting, relax retention and partial retention VQOs by one class. The intent was to gauge what the maximum impact of partial harvesting might be.
	Value Strategy 1	Treat existing and future managed stands to maximize stand value; minimum harvest criteria 350 m^3 per ha in conventional harvest areas and at 450 m^3 per ha in helicopter harvest areas. Consistent with the volume strategies, fertilize existing and future managed Fd stands at ages 30, 40, 50, 60 and 70 on good and medium sites 10+ years before harvest. Consistent with the volume strategies, on potential root rot sites in the East zone complete stumping and plant a higher density of a mix of mostly Fd with some Pw. Existing stands: space Hw/Cw stands in the West zone on good and medium sites to remove competing Hw ingress and favour Cw Future stands: where ecologically suitable, plant high genetic gain Cw instead of Hw or Fd at a density of 1200 sph or higher and space to favour Cw where natural ingress is found to compete with planted Cw crop trees. Climate change models suggest Cw may be less suitable in the drier, warmer subzones and site series in the East zone. Sites not suitable for Cw in the East zone should be planted with high genetic gain Fd. On suitable sites in the East zone plant Dr at higher densities and juvenile space and schedule harvesting for between age 25 and 35 years.

	Value Strategy 2	Same as value strategy 1 except minimum harvest criteria set at age where 95% of the mean annual increment (MAI) culmination is achieved for each managed stand yield curve.
	Value Strategy 3	Increase the minimum harvest age (MHA) to MAI culmination. This scenario tested the impact of setting the minimum harvest age at the age where the MAI culmination is achieved. No future silviculture investments were included.
	Biodiversity and habitat strategy 1	Follow the NOGO draft federal recovery strategy management direction with a 40% target of forage habitat within the forage area surrounding known and modelled breeding areas.
	Biodiversity and habitat strategy 2	Follow the NOGO draft federal recovery strategy management direction with a 60% target of forage habitat within the forage area surrounding known and modelled breeding areas.
	Biodiversity and habitat strategy 3	Establish a TSA-wide NOGO forage habitat target of 40%.
	Biodiversity and habitat strategy 4	This scenario followed the recovery strategy for MAMU with the conservation area targets. The target was set at 60% of the 2002 habitat in the West zone and 90% in the East zone. There was no TLHB in the East zone, so the target there was not relevant.
	Biodiversity and habitat strategy 5	This scenario tested the impact of higher retention levels for riparian management zones (RMZ). RMZs were removed from the THLB.
	IRMP Selected Scenario	See section 8

Table 8 provides a summary of the scenario results for various indicators. The pluses (+) and minuses (-) depict a somewhat subjective classification of predicted indicator values for each scenario. More is depicted with pluses and less is depicted with minuses. The rating of Footprint is the inverse of Harvest Area, i.e. less harvest area creates less of a footprint. This is in turn assumed to maintain more habitat for various species.

Table 8: Scenario timber supply impacts

Scenario	Indicator							
	Volume	**Value**	**Harvest Area**	**NOGO Forage Habitat**	**MAMU Habitat**	**Old CW Volume**	**Old Seral Stage Area**	**Footprint**
Volume Strategy 1; TSR MHA	++	--	++	0	0	0	0	-
Volume Strategy 2; 95% MAI	+ MT +++ LT	+ LT	0	0	0	0	0	0
Value Strategy 1; TSR MHA	+	+ LT	+	0	0	0	0	-
Value Strategy 2; 95% MAI	0 ST, ++ LT	+++	--	0	0	0	0	++
Value Strategy 3; Strict MAI	---	+++ LT	---	+++ ST, 0 LT	+ ST, 0 LT	0	+ ST, 0 LT	---
Biodiversity and Habitat Strategy 5; Riparian	--	0	-	+	+	+	+	+
Volume Strategy 3; VQO	+	0	+	-	-	-	-	-
Biodiversity and Habitat Strategy 1; NOGO 40	0	0	0	+ (dist)	0	0	0	0
Biodiversity and Habitat Strategy 2; NOGO 60	- (LT)	0	- (LT)	+ (dist & area)	0	0	0	+
Biodiversity and Habitat Strategy 3; NOGO CFLB	0	0	0	0	0	0	0	0
Biodiversity and Habitat Strategy 4; MAMU	0	0	0	0	++	+	+	+

8 IRMP Selected Management Scenario

Significant conclusions from the learning scenarios include:

- The short and mid-term harvest levels were adversely affected by the strict MAI harvest rule.
- Increased riparian retention decreased the harvest forecast throughout the planning horizon.
- The maintenance of high level (60%) of NOGO forage habitat reduced the long-term harvest forecast moderately.
- Harvest area (footprint) was the greatest in the volume scenarios due to harvest criteria.
- Biodiversity indicators were either insensitive or positively affected by changes in management (higher harvest ages and silviculture treatments).
- The relaxation of the visual quality constraints had a negative impact on biodiversity indicators.

The analysis results of the various management scenarios were presented to the Arrowsmith IRMP stakeholder group on March 10, 2017. The group agreed that the value scenarios, with some control over the minimum harvest age for managed stands, should be the basis for the IRMP Selected Management Scenario and the ensuing tactical silviculture treatment schedule, because it provides the following benefits:

- Highest estimated value of all scenarios;
- Higher long-term volume compared to the base case;
- Smaller harvest footprint compared to the base case and most other scenarios; and,
- Performed as well or better on biodiversity indicators as the IRMP Base Case.

The IRMP Selected Management Scenario reduces the harvest forecast in the short and medium term; however this reduction is small (3.1%).

The following additional components were incorporated into the IRMP Selected Management Scenario:

- Extreme and high fire threat areas within the urban interface buffers were classified as red, i.e. these areas are not candidates for incremental silviculture investments. However, stand-level treatment regimes, as identified for high risk areas within a community wildfire protection plan, may be considered in these zones to reduce fire risk.
- Including suitable future Cw stands in the fertilization program is recommended; however this was not modeled due to lack of appropriate fertilization response research of Cw stands.
- Minimum harvest criteria outside of green and yellow zones is the same as used in the latest TSR (350 m^3 per ha conventional and 450 m^3 per ha helicopter). Within the green and yellow zones the harvest criteria was set at the age where 95% of the MAI culmination is achieved based on TASS output.
- NOGO forage areas targets are to be applied (40%).

8.1 IRMP Selected Management Scenario Results

Figure 5 illustrates a harvest forecast comparison between the IRMP Base Case and the IRMP Selected Scenario. The predicted harvest level of the IRMP Selected Scenario is 3.1% lower than that of the IRMP Base Case until year 125 (266, 600 m^3 per year vs. 275,000 m^3 per year), when the transition to the long term harvest level (LTHL) occurs. The IRMP Selected Scenario harvest level is predicted to be 8.2 % higher than that of the IRMP Base Case between years 126 and 190 (297, 550 m^3 per year vs. 275,000 m^3 per year), and 4.6% higher in the long term (297,550 m^3 per year vs. 284,400 m^3 per year).

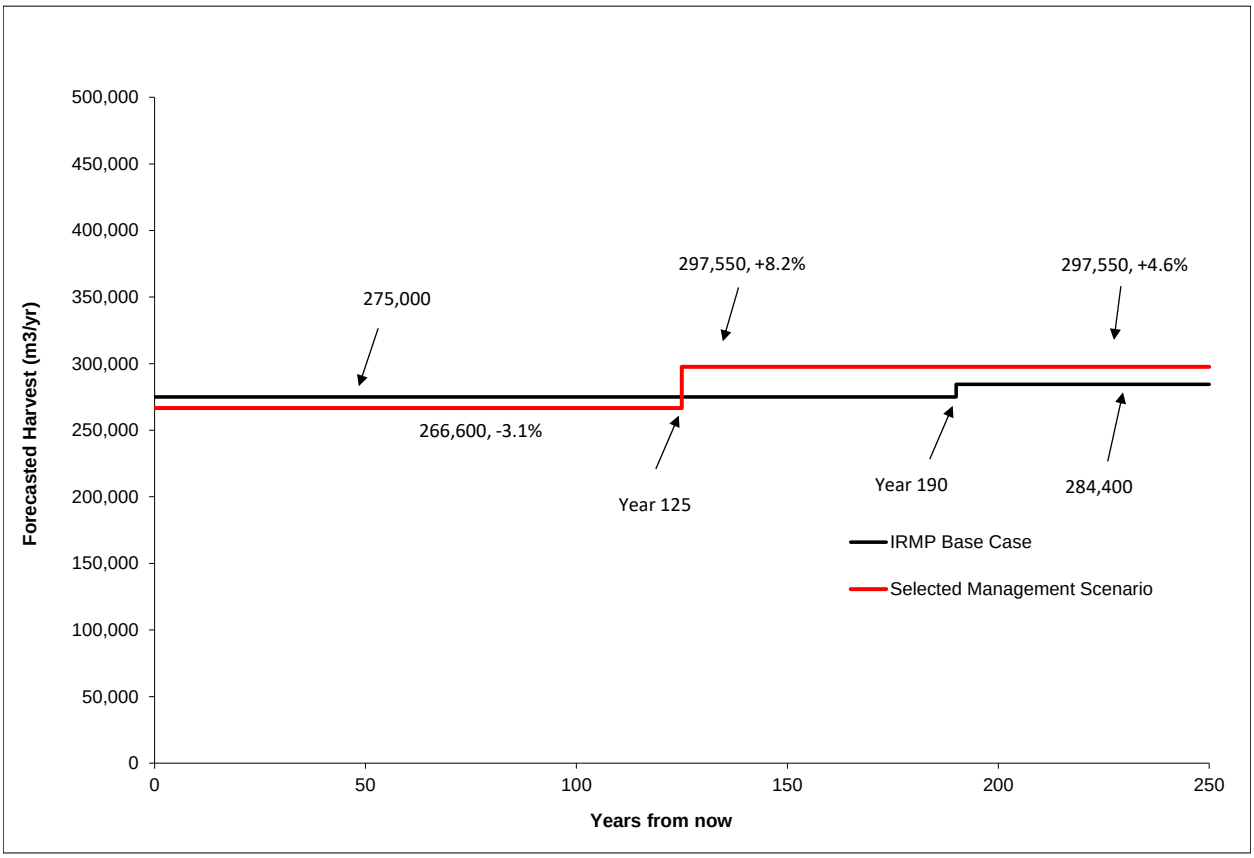

Figure 5: Harvest forecast; IRMP Selected Management Scenario

The analysis results for the IRMP Selected Management Scenario are described in detail in the Modelling and Analysis Report (FESL, 2017). The summary is provided below:

- Some stands are held somewhat longer than in the IRMP Base Case and harvested at older ages than in the IRMP Base Case.
- The higher harvest age and increased growth through fertilization result in a higher average harvest volume and a higher long-term growing stock compared the IRMP Base Case.
- The IRMP Selected Management Scenario favours management for Cw over Hw and Fd in ecologically suitable parts of the West zone to create value. As a result, the predicted harvest of Cw volume relative to total harvest volume increases over time at the expense of Hw and Fd harvest volume.

- The IRMP Selected Management Scenario relies on the harvest of mostly age class 9 stands from the West zone, and stands greater than 60 years old from the East zone in the short term. In the long term, the majority of the harvest is expected to come from age class 3 and 4 stands (41 to 80 years old).
- On average, approximately 94,000 m^3 of the future harvest is expected to occur in the East zone over the planning horizon.
- While on average around 12% the harvest is predicted to come from helicopter harvested stands over the planning horizon; the helicopter harvest percent varies between 7% and 24% depending on the harvest period. Practically all helicopter harvest is predicted to occur in the West zone.
- In the long term, the IRMP Selected Management Scenario is predicted to create significantly more timber value from managed stands. Compared to the IRMP Base Case, the value increase starts around year 70 coinciding with the increase in Cw harvest.
- From year 50 on, less area is generally harvested to yield almost the same volume when compared to the IRMP Base Case.

Harvest forecasts rely on a variety of assumptions that are subject to uncertainty. As a rule, forest level analyses attempt to use the best available information and the most current analyses assumptions. As a consequence, the forest is expected to be harvested more or less as modeled. It is also expected to grow more or less as predicted through growth and yield modelling.

If forest practices differ significantly from the assumptions used in the analysis, the available timber supply can be substantially different from this forecast. Assumptions regarding harvest ages in the East zone and the amount of harvest to come from mature hemlock-balsam helicopter operable stands in the West zone are different in this analysis from what has been achieved recently in the Arrowsmith TSA.

9 Harvest Strategy (10 Years)

The various strategies presented in this report are intended to form the basis for a set of tactical plans. These plans attempt to show planned management activities spatially and temporally. The tactical plan needs to be consistent with the IRMP Selected management scenario; the proposed operational harvesting and treatments should trend towards the objectives identified in this project and not jeopardize the achievement of those objectives.

It is important to note that in practice, tactical plans are prepared through iterative analyst – operational staff interaction and usually include a significant field component. First iterations of model created treatment areas (harvest, silviculture) are used as a starting point for the preparation the operational schedules. The final schedules are eventually incorporated back into to the spatial timber supply model to test the schedule in terms of its overall sustainability and consistency with the existing strategic plans. This process can be detailed and time consuming, particularly in determining access, block sizes and related costs.

The strategies and tactical plans in this project have not been prepared using the above described process. No detailed costs, issues with access and block sizes etc. have been considered. As a result, the presented strategies and plans are conceptual and should be taken as guidelines when developing final operational harvest schedules or tactical silviculture treatment plans (e.g., fertilization or spacing).

9.1 East/West Split

Over the next 10 years, approximately 69% of the harvest - on average 185,162 m^3 annually - is expected to come from the West zone. The remaining 31% of the harvest is predicted to come from the East zone (approximately 81,460 m^3 annually).

Table 9: Total 10-year harvest forecast by east/west split

Years	East		West		Total
	Volume m^3	%	Volume m^3	%	Volume m^3
1 to 5	248,266	18.6%	1,084,843	81.4%	1,333,110
6 to 10	566,333	42.5%	766,776	57.5%	1,333,110
Total 10 Years	**814,600**	**30.6%**	**1,851,620**	**69.4%**	**2,666,219**

Table 10: Annual harvest forecast over 10 years by east/west split

Years	East		West		Total
	Volume m^3/yr	%	Volume m^3/yr	%	Volume m^3/yr
1 to 5	49,653	18.6%	216,969	81.4%	266,622
6 to 10	113,267	42.5%	153,355	57.5%	266,622
Average Annual	**81,460**	**30.6%**	**185,162**	**69.4%**	**266,622**

9.2 West Zone

9.2.1 Age Classes

Almost the entire harvest in the West zone over the next 10 years should come from age class 8 and 9 stands (99.9%, Table 11). This may not be realistic; however, it is necessary for the timber supply forecast to remain valid.

Table 11: Predicted harvest by age class in the west zone

Years	Total Harvest by Age Class (m^3)						Total
	Age Class						
	4	5	6	7	8	9	
1 to 5	0	42	0	0	90,405	994,396	**1,084,843**
6 to 10	550	159	605	91	37,678	727,693	**766,776**
Total	550	201	605	91	128,083	1,722,089	**1,851,620**

Years	Total Harvest by Age Class (%)						Total
	Age Class						
	4	5	6	7	8	9	
1 to 5	0.0%	0.0%	0.0%	0.0%	8.3%	91.7%	**100.0%**
6 to 10	0.1%	0.0%	0.1%	0.0%	4.9%	94.9%	**100.0%**
Total	0.0%	0.0%	0.0%	0.0%	6.9%	93.0%	**100.0%**

9.2.2 Species

The majority of the West zone harvest in the next 10 years (56%) consists of Hw or Ba species as depicted in Table 12. The share of Cw and Yc is approximately 39%.

Table 12: Predicted harvest by species in the West zone

Years	Total Harvest by Species (m^3)								Total
	Ba	Cw	Decid	Fd	Hw	Pl	SS	Yc	
1 to 5	200,586	348,594	1,144	31,224	468,225	468	17,252	17,351	**1,084,843**
6 to 10	72,325	307,795	1,128	29,146	297,293	223	3,788	55,079	**766,776**
Total	272,910	656,388	2,272	60,370	765,518	690	21,040	72,431	**1,851,620**
Years	**Total Harvest by Species (%)**								**Total**
	Ba	Cw	Decid	Fd	Hw	Pl	SS	Yc	
1 to 5	18.5%	32.1%	0.1%	2.9%	43.2%	0.0%	1.6%	1.6%	**100.0%**
6 to 10	9.4%	40.1%	0.1%	3.8%	38.8%	0.0%	0.5%	7.2%	**100.0%**
Total	14.7%	35.4%	0.1%	3.3%	41.3%	0.0%	1.1%	3.9%	**100.0%**

9.2.3 Harvest Method

Approximately 77% of the short-term harvest (10 years) in the West zone is predicted to come from stands where conventional harvesting can be employed. For the harvest forecast to hold, the balance of the harvest in the West zone must come from helicopter operable stands. Of all the West zone helicopter-operable stands harvested in the timber supply model in the first 10 years of the planning horizon, 55 % were Cw and Yc stands, while the share of Hw and Ba was 38% (Table 13).

Table 13: Predicted harvest by harvest method in the West zone

Years	Total Harvest by Method (m^3)		Total
	Ground	Heli	
1 to 5	884,127	200,716	**1,084,843**
6 to 10	543,580	223,196	**766,776**
Total	**1,427,707**	**423,913**	**1,851,620**
	Total Harvest by Method %		**Total**
Years	Ground	Heli	
1 to 5	81.5%	18.5%	**100.0%**
6 to 10	70.9%	29.1%	**100.0%**
Total	**77.1%**	**22.9%**	**100.0%**

Table 14: Predicted harvest by species and harvest method in the West zone

Years	Total Harvest by Species and Method (m^3)									Total
	Method	**Ba**	**Cw**	**Decid**	**Fd**	**Hw**	**Pl**	**SS**	**Yc**	
1 to 5	**Ground**	39,035	49,031	175	3,640	79,089	94	3,151	2,611	**176,825**
	Heli	1,082	20,688	54	2,605	14,556	0	300	859	**40,143**
	Total	**40,117**	**69,719**	**229**	**6,245**	**93,645**	**94**	**3,450**	**3,470**	**216,969**
6 to 10	**Ground**	13,266	38,664	226	2,820	44,231	45	464	9,001	**108,716**
	Heli	1,199	22,895	0	3,009	15,227	0	294	2,015	**44,639**
	Total	**14,465**	**61,559**	**226**	**5,829**	**59,459**	**45**	**758**	**11,016**	**153,355**
Total 10 Years	**Ground**	195,177	245,154	876	18,201	395,443	468	15,753	13,055	**884,127**
	Heli	5,408	103,439	268	13,024	72,782	0	1,499	4,296	**200,716**
	Total	**200,586**	**348,594**	**1,144**	**31,224**	**468,225**	**468**	**17,252**	**17,351**	**1,084,843**
Years	**Total Harvest by Species and Method (%)**									**Total**
	Method	**Ba**	**Cw**	**Decid**	**Fd**	**Hw**	**Pl**	**SS**	**Yc**	
1 to 5	**Ground**	22.1%	27.7%	0.1%	2.1%	44.7%	0.1%	1.8%	1.5%	**100.0%**
	Heli	2.7%	51.5%	0.1%	6.5%	36.3%	0.0%	0.7%	2.1%	**100.0%**
	Total	**18.5%**	**32.1%**	**0.1%**	**2.9%**	**43.2%**	**0.0%**	**1.6%**	**1.6%**	**100.0%**
6 to 10	**Ground**	12.2%	35.6%	0.2%	2.6%	40.7%	0.0%	0.4%	8.3%	**100.0%**
	Heli	2.7%	51.3%	0.0%	6.7%	34.1%	0.0%	0.7%	4.5%	**100.0%**
	Total	**9.4%**	**40.1%**	**0.1%**	**3.8%**	**38.8%**	**0.0%**	**0.5%**	**7.2%**	**100.0%**
Total 10 Years	**Ground**	18.3%	30.7%	0.1%	2.3%	43.2%	0.0%	1.3%	4.1%	**100.0%**
	Heli	2.7%	51.4%	0.1%	6.6%	35.1%	0.0%	0.7%	3.4%	**100.0%**
	Total	**14.7%**	**35.4%**	**0.1%**	**3.3%**	**41.3%**	**0.0%**	**1.1%**	**3.9%**	**100.0%**

9.2.4 Woodsheds

Approximately 82% of the West zone harvest over the next 10 years is predicted to come from four woodsheds: Toquart/Lucky (31.3%), Escalante (24.2%), Handy (15.2%) and Effingham (11.3%). The predicted shares of other woodsheds are shown in Table 15.

Table 15: Predicted harvest by woodshed in the West zone

Woodshed	Years 1 to 5	Years 6 to 10	10-Year Total	Percent of Total	Cumulative Percent
Toquart/Lucky	397,046	177,831	574,877	31.3%	31.3%
Escalante	232,636	217,055	449,691	24.2%	55.4%
Handy	140,721	142,882	283,603	15.2%	70.7%
Effingham	155,987	53,176	209,163	11.4%	82.1%
Sechart/Cataract/Pipestem	55,238	43,912	99,150	5.3%	87.4%
San Juan	24,179	25,776	49,955	2.7%	90.1%
Tzartus	37,529	29,536	67,065	3.6%	93.7%
No Name	23,442	32,273	55,715	3.0%	96.7%
Outside Woodsheds	9,649	18,845	28,495	1.5%	98.2%
Vernon Bay	8,415	24,895	33,311	1.8%	100.0%
Browns Ridge	0	594	594	0.0%	100.0%
Effingham BCTS	0	0	0	0.0%	100.0%
Rosander	0	0	0	0.0%	100.0%
Sarita	0	0	0	0.0%	100.0%
Total	**1,084,843**	**766,776**	**1,851,620**	**100.0%**	**100.0%**

9.3 East Zone

9.3.1 Age Classes

The entire harvest in the East zone over the next 10 years should come from stands older than 60 years. (100%). As noted with the West zone analysis, this may not be realistic; however, it is necessary for the timber supply forecast to remain sustainable. The predicted 10-year harvest consists mostly of stands between 61 and 100 years old (age classes 4 and 5) (69 %, Table 16). Older age classes are also harvested; the total harvest in age classes 6 to 9 is 31 % of the East zone total (Table 16).

Table 16: Predicted harvest by age class in the East zone

Years	Total Harvest by Age Class (m^3)							Total
	Age Class							
	3	4	5	6	7	8	9	
1 to 5	0	41,948	103,820	26,922	25,731	49,845	0	**248,266**
6 to 10	420	151,037	268,101	117,408	6,531	22,837	0	**566,333**
Total	**420**	**192,985**	**371,922**	**144,329**	**32,262**	**72,683**	**0**	**814,600**

Years	Total Harvest by Age Class (%)							Total
	Age Class							
	3	4	5	6	7	8	9	
1 to 5	0.0%	16.9%	41.8%	10.8%	10.4%	20.1%	0.0%	**100.0%**
6 to 10	0.1%	26.7%	47.3%	20.7%	1.2%	4.0%	0.0%	**100.0%**
Total	**0.1%**	**23.7%**	**45.7%**	**17.7%**	**4.0%**	**8.9%**	**0.0%**	**100.0%**

9.3.2 Species

The majority of the East zone harvest (76%) is Fd. The shares of Hw and Cw are approximately 13% and 3% respectively (Table 17).

Table 17: Predicted harvest by species in the East zone

Years	Total Harvest by Species (m^3)								Total
	Ba	Cw	Decid	Fd	Hw	Pl	SS	Yc	
1 to 5	483	7,926	25,378	188,830	24,661	757	231	0	**248,266**
6 to 10	1,973	14,165	35,886	432,442	80,504	1,306	13	44	**566,333**
Total	**2,456**	**22,092**	**61,264**	**621,272**	**105,165**	**2,063**	**244**	**44**	**814,600**
Years	**Total Harvest by Species (%)**								**Total**
	Ba	**Cw**	**Decid**	**Fd**	**Hw**	**Pl**	**SS**	**Yc**	
1 to 5	0.2%	3.2%	10.2%	76.1%	9.9%	0.3%	0.1%	0.0%	**100.0%**
6 to 10	0.3%	2.5%	6.3%	76.4%	14.2%	0.2%	0.0%	0.0%	**100.0%**
Total	**0.3%**	**2.7%**	**7.5%**	**76.3%**	**12.9%**	**0.3%**	**0.0%**	**0.0%**	**100.0%**

9.3.3 Harvest Method

Almost the entire harvest (97%) in the East zone over the next 10 years is predicted to come from stands where conventional harvesting can be employed (ground, cable) (Table 18).

Table 18: Predicted harvest by harvest method in the East zone

Years	Total Harvest by Method (m^3)		Total
	Ground	Heli	
1 to 5	242,630	5,636	**248,266**
6 to 10	549,918	16,415	**566,333**
Total	**792,549**	**22,051**	**814,600**
Years	**Total Harvest by Method %**		**Total**
	Ground	**Heli**	
1 to 5	97.7%	2.3%	**100.0%**
6 to 10	97.1%	2.9%	**100.0%**
Total	**97.3%**	**2.7%**	**100.0%**

Table 19: Predicted harvest by species and harvest method in the East zone

Years	Total Harvest by Species and Method (m^3)									Total
	Method	**Ba**	**Cw**	**Decid**	**Fd**	**Hw**	**Pl**	**SS**	**Yc**	
1 to 5	Ground	479	7,778	25,259	184,300	23,830	753	231	0	**242,630**
	Heli	4	149	118	4,530	831	4	0	0	**5,636**
	Total	**483**	**7,926**	**25,378**	**188,830**	**24,661**	**757**	**231**	**0**	**248,266**
6 to 10	Ground	1,932	13,854	35,815	418,972	77,999	1,289	13	44	**549,918**
	Heli	41	311	71	13,470	2,505	17	0	0	**16,415**
	Total	**1,973**	**14,165**	**35,886**	**432,442**	**80,504**	**1,306**	**13**	**44**	**566,333**
Total 10 Years		2,456	22,092	61,264	621,272	105,165	2,063	244	44	814,600

Years	Total Harvest by Species and Method (%)									Total
	Method	**Ba**	**Cw**	**Decid**	**Fd**	**Hw**	**Pl**	**SS**	**Yc**	
1 to 5	**Ground**	0.2%	3.2%	10.4%	76.0%	9.8%	0.3%	0.1%	0.0%	**100.0%**
	Heli	0.1%	2.6%	2.1%	80.4%	14.8%	0.1%	0.0%	0.0%	**100.0%**
	Total	**0.2%**	**3.2%**	**10.2%**	**76.1%**	**9.9%**	**0.3%**	**0.1%**	**0.0%**	**100.0%**
6 to 10	**Ground**	0.4%	2.5%	6.5%	76.2%	14.2%	0.2%	0.0%	0.0%	**100.0%**
	Heli	0.2%	1.9%	0.4%	82.1%	15.3%	0.1%	0.0%	0.0%	**100.0%**
	Total	**0.3%**	**2.5%**	**6.3%**	**76.4%**	**14.2%**	**0.2%**	**0.0%**	**0.0%**	**100.0%**
Total 10 Years		**0.3%**	**2.7%**	**7.5%**	**76.3%**	**12.9%**	**0.3%**	**0.0%**	**0.0%**	**100.0%**

9.3.4 Woodsheds

Approximately 67% of the East zone harvest over the next 10 years is predicted to come from three woodsheds: Mayo/Hillcrest (27.7%), Mt. Brenton (20.9%) and Holland (19.1%). Approximately 13% of the harvest forecast comes from areas outside of designated woodsheds. The predicted shares of other woodsheds are shown in Table 20.

Table 20: Predicted harvest by woodshed in the East zone

Woodshed	Years 1 to 5 (m^3)	Years 6 to 10 (m^3)	10-Year Total (m^3)	Percent of Total	Cumulative Percent
Mayo/Hillcrest	72,123	153,231	225,354	27.7%	27.7%
Mt Brenton	32,492	137,575	170,067	20.9%	48.5%
Holland	23,435	131,822	155,257	19.1%	67.6%
Outside Woodsheds	77,322	32,137	109,459	13.4%	81.0%
Koksilah	11,946	78,354	90,300	11.1%	92.1%
Rosewall	23,366	11,141	34,507	4.2%	96.4%
Mt Wesley	7,258	21,869	29,128	3.6%	99.9%
Shawnigan	324	204	528	0.1%	100.0%
McKay Lake	0	0	0	0.0%	100.0%
Mt. Benson	0	0	0	0.0%	100.0%
Total	**248,266**	**566,333**	**814,600**	**100.0%**	**100.0%**

9.4 Spatial Harvest Schedule

The harvest schedule for the first 10 years of the planning horizon created by the model is presented in Figure 6 and Figure 7.

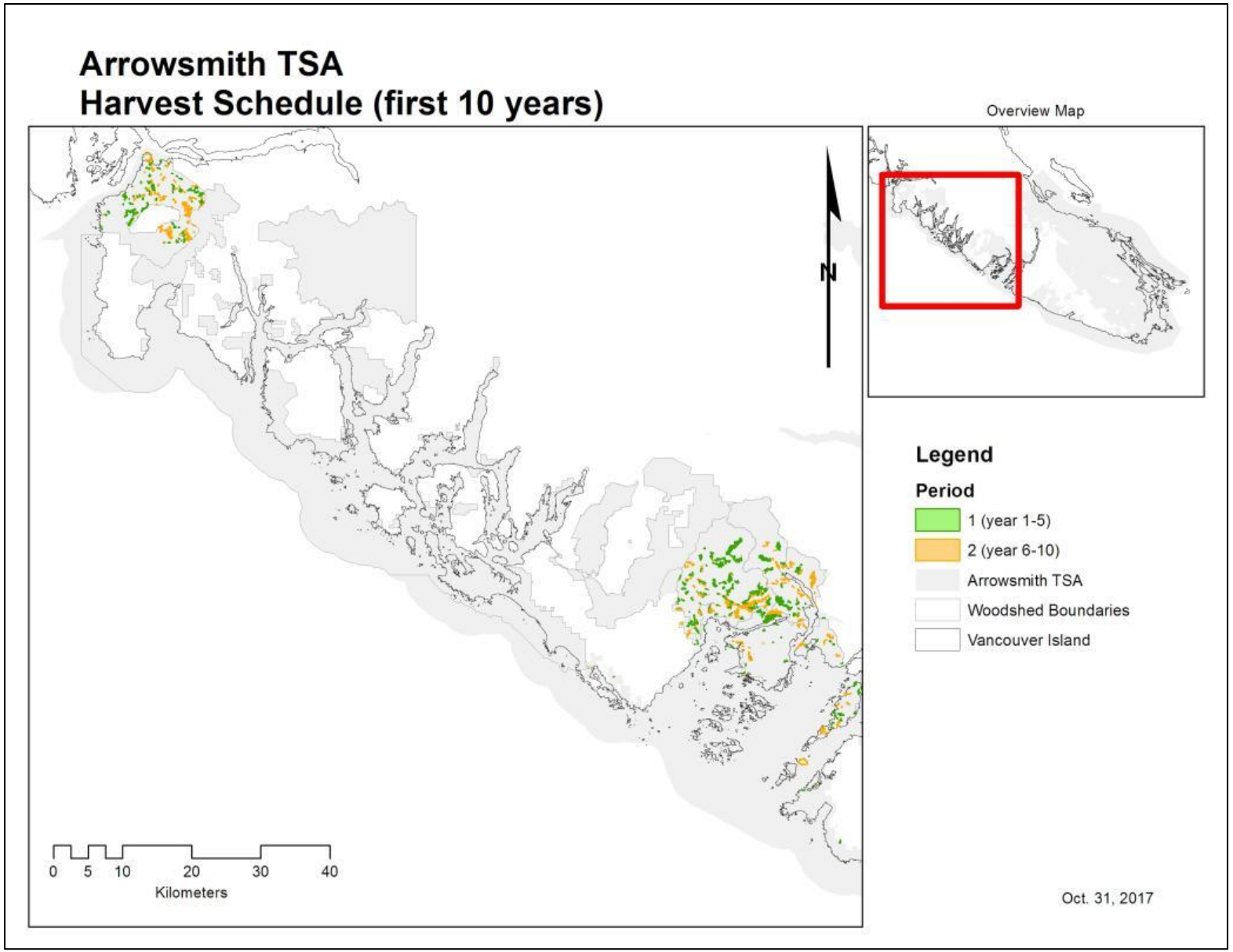

Figure 6: Conceptual harvest schedule, North West, years 1 to 10

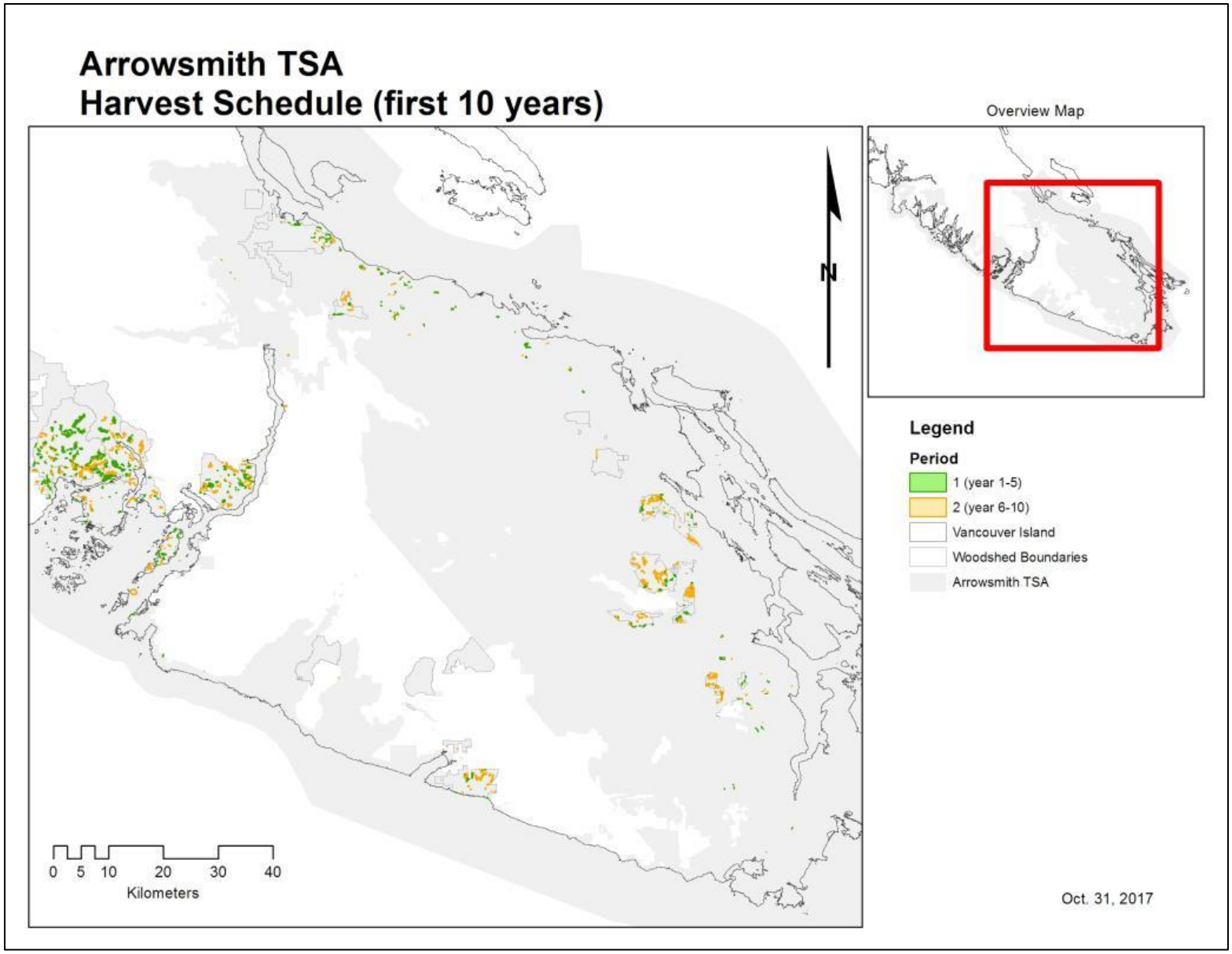

Figure 7: Conceptual harvest schedule, South East, years 1 to 10

10 Silviculture Strategy

The silviculture strategy was designed by the Arrowsmith TSA silviculture working group[3]. The strategy consists of fertilization of young Fd stands and spacing of young Cw plantations to favour Cw over competing Hw ingress. Where ecologically appropriate some harvested Hw and Fd leading stands will be reforested with Cw. All future Cw stands are planted with an increased density of 1,200 stems per hectare (sph) versus 900 to 1,000 sph as is the current practise. The strategy includes spacing of these future Cw stands to minimize competition from natural regeneration. The spacing of these future Cw stands will start in about 12 to 15 years.

The total predicted short-term treatment costs are $223,900 annually during the first 5 years and $288,250 annually between years 6 and 10 (Table 21).

Table 21: Projected annual area and costs by treatment for the silviculture strategy

Treatment/Activity	Years 1 to 5		Years 6 to 10	
	Area (ha)	Costs ($)	Area (ha)	Costs ($)
Surveys and Studies	n/a	$50,000	n/a	$50,000
Fertilization	110 ha	$55,000	146 ha	$77,000
Spacing	31 ha	$78,000	56 ha	$140,000
Enhanced Cw planting	163 ha	$40,900	85 ha	$21,250
Annual Total	**304 ha**	**$223,900**	**287 ha**	**$288,250**

10.1 Fertilization

The silviculture strategy sets an incremental silviculture target of 110 ha of fertilization of Fd leading stands per year for the first 5 years at the cost $55,000 per year. The fertilization program is set to increase to 146 ha per year in the second 5-year period starting 6 years from today. The annual cost is projected at $78,000 for years 6 to 10. Assuming all aspects of the silviculture strategy are implemented, the size of Fd fertilization program is forecast to climb modestly through the next 40 years and then stay relatively stable over the longer term.

Table 22 shows the predicted fertilization areas by woodshed for the next 10 years. The treated stands are contemporary and old existing managed Fd stands. Figure 8 and Figure 9 illustrate the predicted fertilization (and juvenile spacing) areas spatially.

[3] Craig Wickland, Michelle Todd, Joe LeBlanc, Jeff McWilliams, Mark Palmer

Table 22: Predicted fertilization areas by woodshed

Woodshed	Total Area (ha) Years 1 to 5	Total Area Years 6 to 10	10-Year Total	Annual Area (ha) Years 1 to 5	Annual Area (ha) Years 6 to 10
Outside Woodsheds	9	52	60	2	10
Escalante	78	96	174	16	19
Handy	6	2	8	1	0
Holland	49	43	92	10	9
Koksilah	43	31	74	9	6
Mayo/Hillcrest	55	61	116	11	12
McKay Lake	63		63	13	0
Mt Benson	3	69	71	1	14
Mt Brenton	234	153	387	47	31
Mt Wesley		12	12	0	2
Rosander	9	137	146	2	27
Rosewall	1		1	0	0
Sechart/Cataract/Pipestem		72	72	0	14
Total	**548**	**728**	**1276**	**110**	**146**

10.2 Spacing

Approximately 31 ha of young Cw spacing are scheduled annually for the first 5 years at the projected cost of $78,000 per annum. The spacing area is set to increase to 56 ha annually for years 6 to 10 at the cost of $140,000 per annum.

Table 23 shows the predicted juvenile Cw spacing areas by woodshed for the next 10 years. Figure 8 and Figure 9 illustrate the predicted juvenile spacing (and fertilization) areas spatially.

Table 23: Predicted Cw juvenile spacing areas by woodshed

Woodshed	Total Area (ha) Years 1 to 5	Total Area Years 6 to 10	10-Year Total	Annual Area (ha) Years 1 to 5	Annual Area (ha) Years 6 to 10
CLCFC		8	8	0	2
Effingham BCTS		9	9	0	2
Escalante	103	85	188	21	17
Handy	21		21	4	0
Rosander		4	4	0	1
San Juan	10	22	32	2	4
Sechart/Cataract/Pipestem		64	64	0	13
Toquart/Lucky	21	86	108	4	17
Total	**155**	**279**	**434**	**31**	**56**

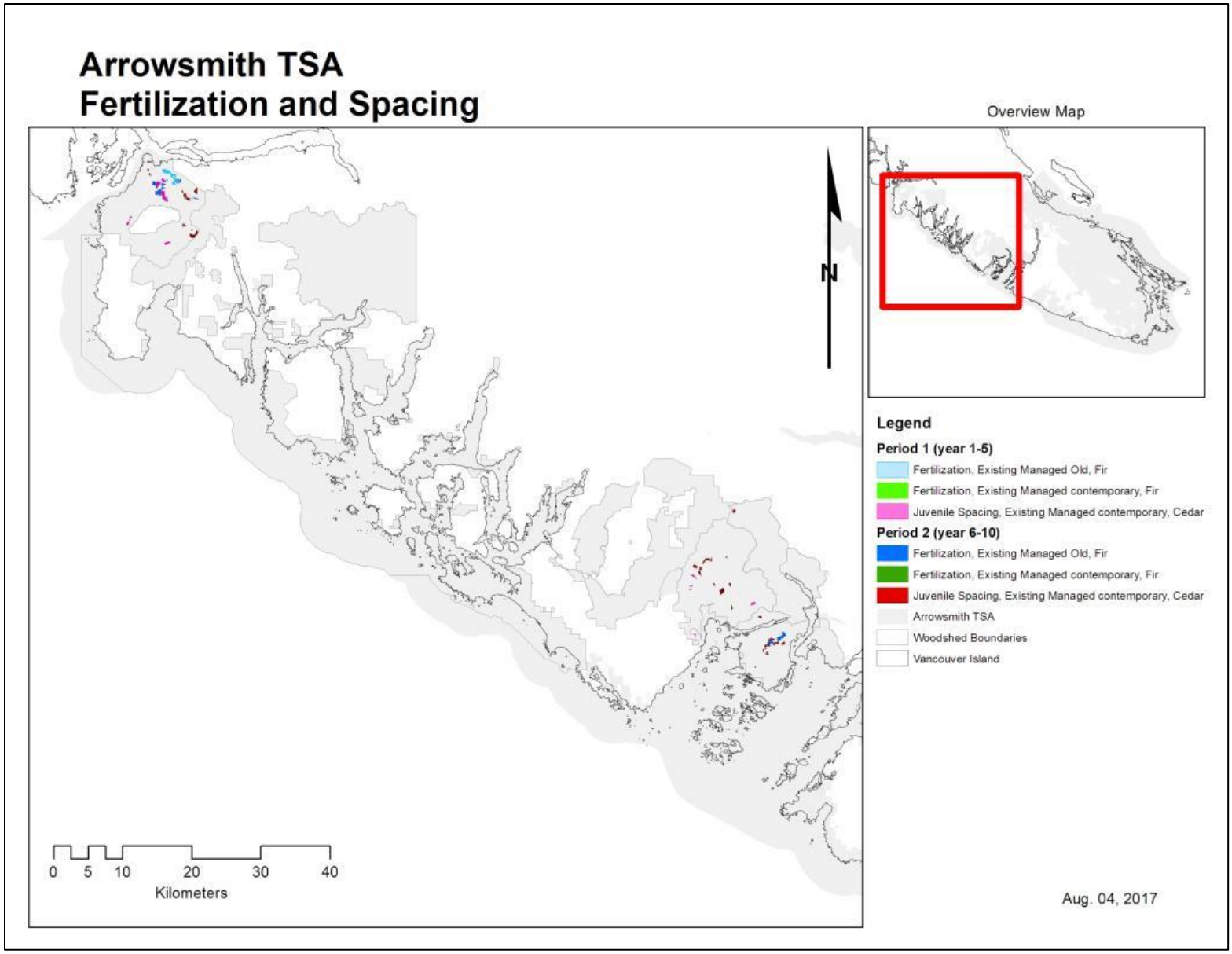

Figure 8: Predicted areas for fertilization and juvenile spacing, North West

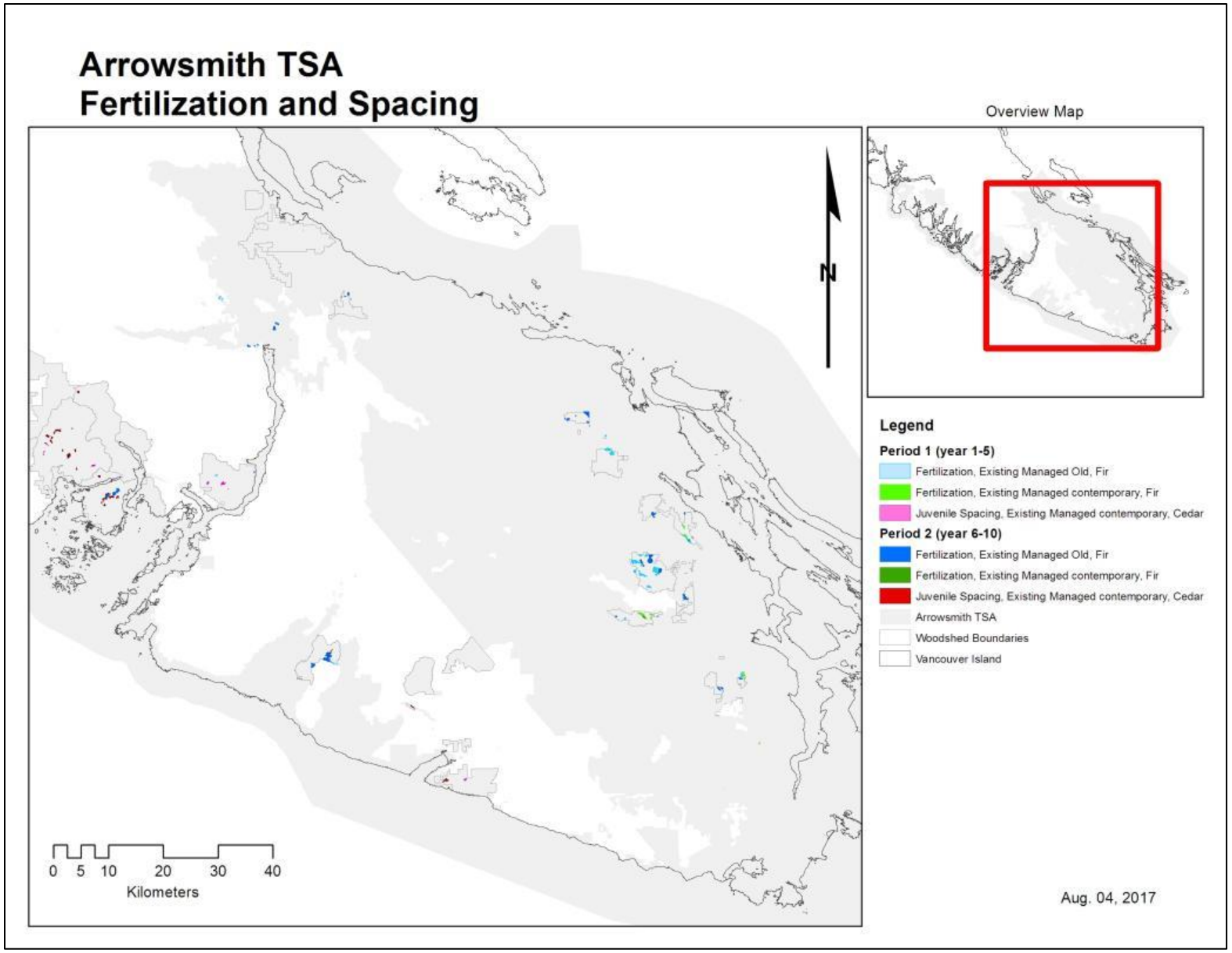

Figure 9: Predicted areas for fertilization and juvenile spacing, South East

10.3 Enhanced Western Redcedar Reforestation

For future stands high genetic gain Cw will be planted on most ecologically suitable sites in the West zone and a portion of the East zone (e.g., wetter, higher elevation portions) with higher densities. Approximately 164 ha and 85 ha of increased density Cw planting is predicted annually for years 1 to 5 and 6 to 10 correspondingly. This increase of 200 to 300 sph is estimated to increase planting costs by approximately $250 per ha (on average). The predicted annual incremental planting costs for years 1 to 5 are $41,900 and $21,250 for years 6 to 10. Note that areas that are planned for Cw reforestation will be assessed using the Climate Change Informed Species Selection tool when available.

Consistent with the current BC stumpage appraisal system and regulations, reforestation costs to achieve the required stocking standards are the responsibility of the tenure holder and the increased costs (including risks of browse, etc.) associated with implementing the enhanced Cw strategy will be borne by the tenure holder at least in the short term. This could be an impediment to effective and widespread implementation of this strategy.

In the longer term the silviculture strategy includes spacing of the enhanced Cw stands which are planned to be established on more sites at the beginning of the planning horizon. This is expected to lead to increased spacing opportunities in about 12 to 15 years. The enhanced Cw reforestation strategy including spacing is the key driver for increased timber values in the long term.

This silviculture strategy does not include fertilization of Cw stands. Some researchers and foresters believe that Cw will respond positively to fertilization with nitrogen on appropriate sites. If so, fertilization of many of the enhanced Cw stands produced under this strategy would have an additional positive impact on the long-term timber supply and value. However, there is limited research quantifying fertilization volume responses on non-Salal Cedar Hemlock Integrated Research Program (SCHIRP) sites. This should be a priority for future research.

Table 24 shows the predicted Cw planting areas for increased planting densities for the next 10 years. Figure 10 and Figure 11 illustrate the predicted increased density planting of Cw spatially.

Table 24: Predicted enhanced Cw planting areas

Woodshed	Total Area Years 1 to 5 (ha)	Total Area Years 6 to 10 (ha)	10-Year Total (ha)	Annual Area Years 1 to 5 (ha)	Annual Area Years 6 to 10 (ha)
Outside Woodsheds	2.5	17.7	20.2	0.5	3.5
Effingham	118.8	17.5	136.3	23.8	3.5
Escalante	194.2	90.8	285.1	38.8	18.2
Handy	128.0	119.3	247.3	25.6	23.9
Mayo/Hillcrest		5.3	5.3	0.0	1.1
Mt Brenton	2.4		2.4	0.5	0.0
Mt Wesley		0.1	0.1	0.0	0.0
No Name	14.5	0.2	14.7	2.9	0.0
San Juan	24.6	87.9	112.4	4.9	17.6
Sechart/Cataract/Pipestem	26.1	1.5	27.5	5.2	0.3
Toquart/Lucky	303.7	76.3	380.1	60.7	15.3
Vernon Bay	2.6	8.6	11.1	0.5	1.7
Total	**817.4**	**425.1**	**1242.5**	**163.5**	**85.0**

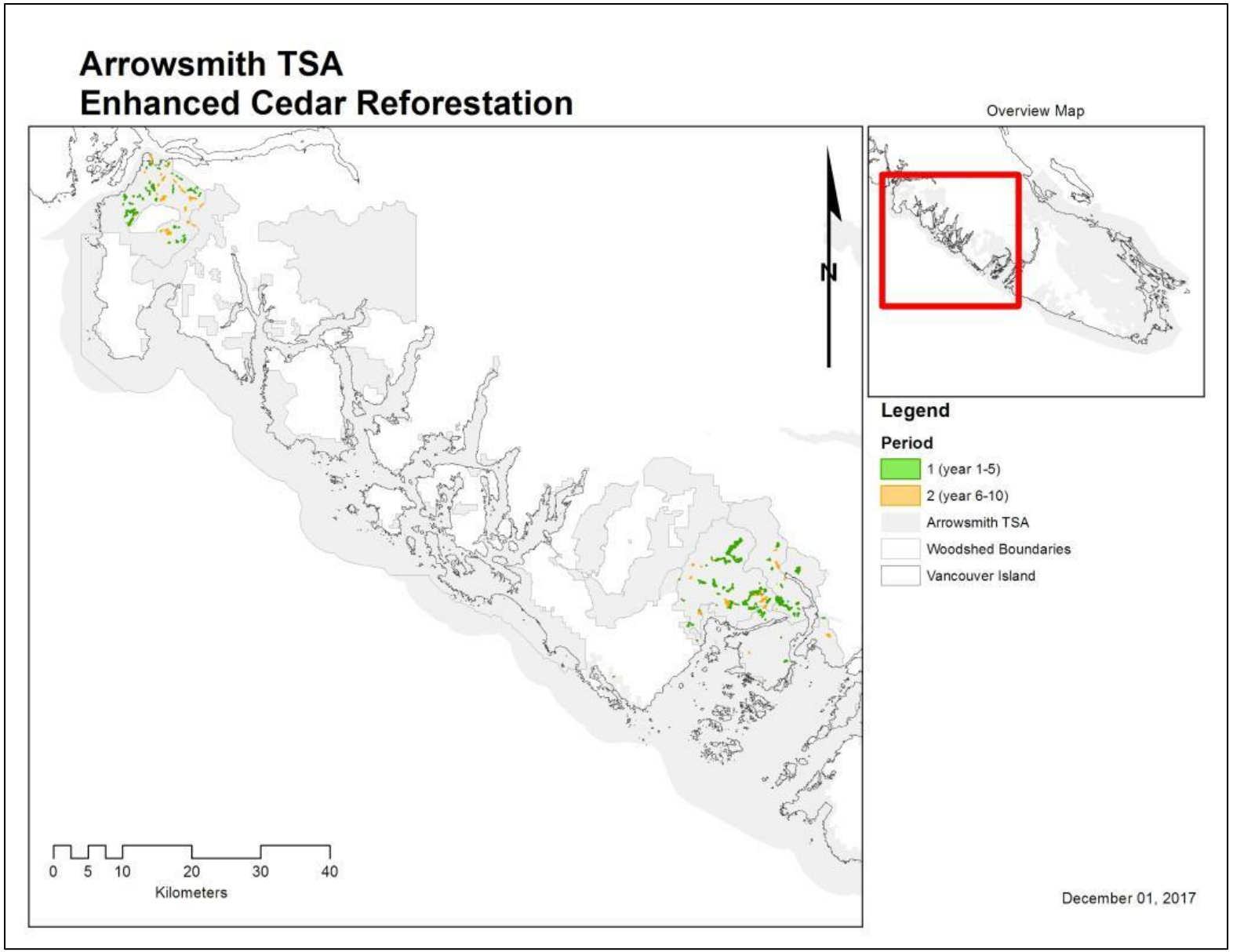

Figure 10: Predicted areas for increased density Cw reforestation, North West

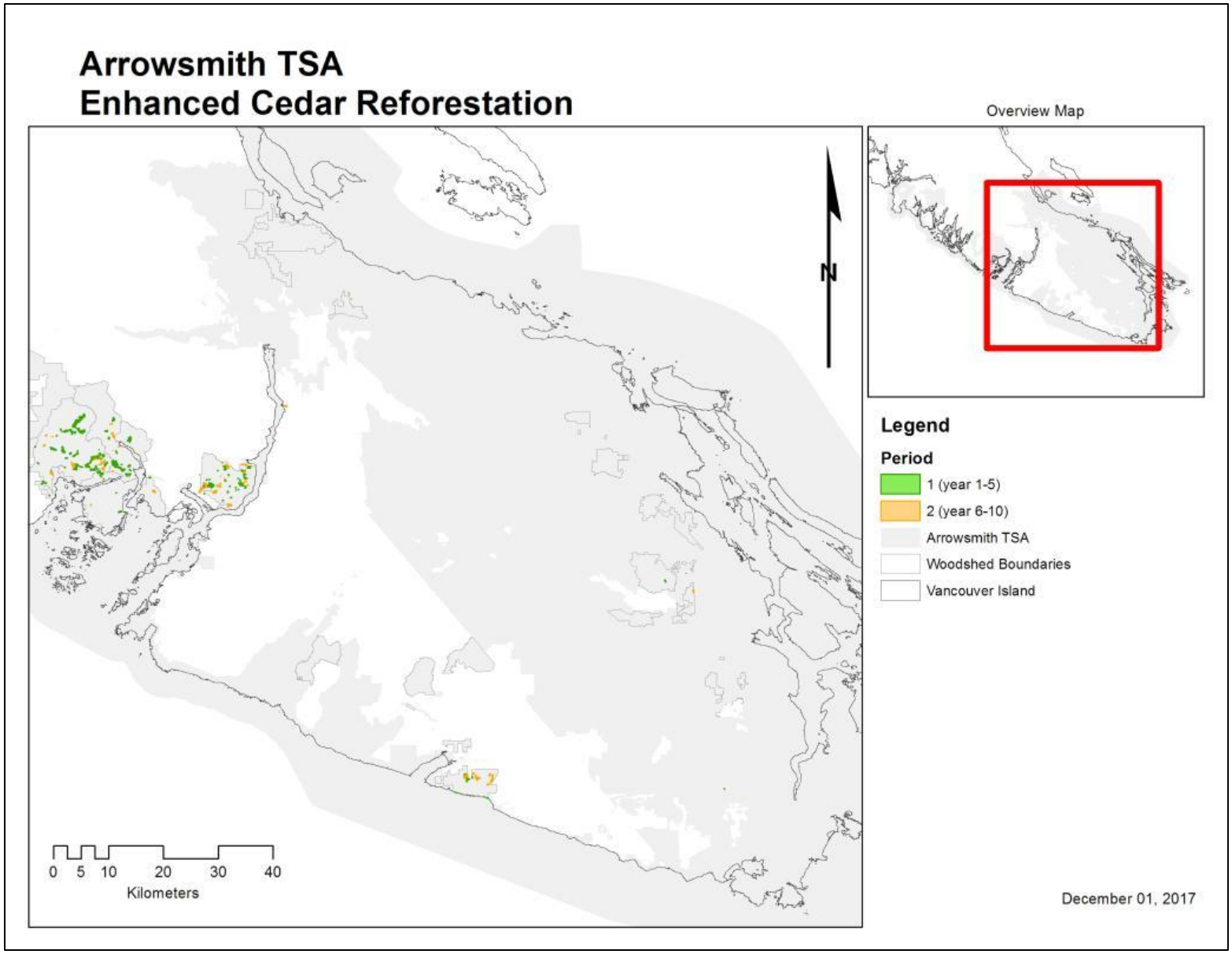

Figure 11: Predicted areas for increased density Cw reforestation, South West

10.4 Surveys and Studies

In this analysis, managed stands were grouped into analysis units based on leading species, growth rating, management status and zone (east/west). This grouping inherently assumes that any stand belonging to a particular group exhibits certain characteristics, such as site index, density and species distribution identically. As a result, all stands within an analysis unit are assumed to grow and respond to silviculture treatments in a similar fashion. In practice, this is not the case. The actual stands within each analysis unit will vary in site index, species composition and physical condition. Some may not be suitable candidates for silviculture treatments for a variety of reasons. Therefore, all candidate areas need to be surveyed and their suitability for treatments confirmed before final investment decisions are made. Fertilization costs noted above include costs for surveys, whereas juvenile spacing costs do not.

This strategy allocates $50,000 annually for surveys and studies in the next 10 years. These studies will help to gain a better understanding of the condition of juvenile spacing candidate stands. The studies will also be used to determine fire threat levels outside of the urban interface areas to help allocate funding for fire threat mitigation. The surveys within the urban interface area is likely funded by the Union of BC Municipalities (UBCM). Fire threat mitigation will be discussed below under section 11.

11 Wildfire Management

The BC Wildland Fire Management Strategy (Government of BC, 2010) has five main components, two of which directly pertain to this plan;

- Reduce fire hazards and risks (particularly in and around communities and other high-value areas) and;
- Implement land, natural resource and community planning that incorporates management of wildland fire at all appropriate scales. Treatments to reduce fire risk within the urban interface will be carried out in accordance with community wildfire protection plans.

In general, silviculture treatments should be planned to reduce wildfire risk and consequences to safety, infrastructure, property and other values. Strategic deployment of thinning treatments can reduce wildfire risk. Other silviculture treatments (primarily fertilization) should be strategically located to minimize the longer-term risk of loss from wildfire. Table 25 shows generalized forest management priorities for wildfire management.

The Wildland Urban Interface (WUI) is any area where combustible wildland fuels (e.g. vegetation) are found adjacent to homes, farm structures or other buildings. The WUI buffer consists of areas within two kilometres of a community with a density of between six and 250 structures per square kilometre. The data in the Arrowsmith TSA was updated to 2015 for built structures, and provided by FLNR for this analysis. It helps identify developed areas that may be at risk due to wildfires and can help guide planning processes for modifying or reducing the amount of forest or range fuels to mitigate the risk of fire in the built environment.

Historically, wildfire planning has been separate from strategies, such as this. In the Arrowsmith TSA, a Provincial Strategic Threat Analysis (PSTA) of wildfire risk has been completed for the WUI at the strategic level to inform the government's landscape fire management planning and fuel treatment programs. The PSTA risk ratings are based on the VRI, and field observations during this project revealed inaccuracies in the fire threat rating in many observed areas. For this reason, this plan did not identify candidate treatment areas. Rather, it recommends that surveys be carried out to confirm risk ratings in

those areas within the WUI, where VRI based ratings indicate concerns. In high or extreme rated areas treatments should be recommended and implemented. Treatments to reduce fire risk were not modeled due to relatively low amount (hectares) of high threat (risk) polygons within the TSA and the inaccuracy of the VRI data as discussed above.

11.1 Potential Treatments

Silviculture treatments usually focus on reducing the canopy bulk density. For existing stands, this can be accomplished through partial harvesting and in some cases pruning treatments, which also reduce the possibility of ground fires reaching into the tree canopy.

Wherever new plantations are established close to communities, consideration should be given to fire management stocking standards:
https://www.for.gov.bc.ca/hfp/silviculture/Fire%20Management%20Stocking%20Standards%20Guidance%20%20Document%20March%202016.pdf

The intent of a fire management stocking standard is to create and sustain conditions in the forest that achieve the objectives set for fire management in a given area within a WUI. Usually the goal is to reduce the probability of aggressive fire behaviour by decreasing the likelihood of crown fire and/or rapid high intensity ground fire.

General examples of fire management stocking standards are:

- Increased use of deciduous species in reforestation in high fire threat areas. Deciduous species may also be desirable in contributing positively towards habitat and biodiversity objectives.
- Increased use of species with smaller canopy bulk density; in ecologically suitable sites Pw can be planted and used instead of Fd for the portion of the planted area.

Table 25: Forest management priorities for wildfire management

Treatments		Treatment Outcome (Fire Perspective)	Lower priority where	Higher priority where
Harvesting	Clearcut	Reduce fuel loading and eliminate crown fire risk (short term)		High values and high hazards exist; create fuel breaks
	Partial cut	Reduce crown bulk density - reduce crown fire risk (1); may increase surface fuel loading (2)		High risk interface area (3) identifies a need to treat fuels; mitigate risk
Silviculture	Enhanced Reforestation	May have surface fire potential, depending on residual slash load and grass/ herbaceous fuel loading	Burn probability is highest; avoid lost silviculture investments	
	Alternate Reforestation (4)	May have surface fire potential, depending on residual slash load and grass/ herbaceous fuel loading		Burn probability is highest; mitigate losses and protect values
	Prescribed Burn / Ecosystem Restoration	Maintains a natural fire return interval		High values exist with high hazard and risk; treat fuels and improve forest health/habitat
	Spacing to normal stocking levels	Reduce fuel loading – lower fire intensity; may increase surface fuel loading	Burn probability is highest; avoid lost silviculture investments	

Treatments		Treatment Outcome (Fire Perspective)	Lower priority where	Higher priority where
	Spacing to lower densities combined with fuel reduction	Reduce fuel loading – lower fire intensity (5)		High values exist to protect community and Infrastructure High risk interface area (3) identifies a need to treat fuels; mitigate risk Burn probability and fire intensity criteria are the highest; mitigate fuel loading
	Fertilization	May increase crown bulk density and higher surface fuel loading (due to increased growth of understory vegetation)	Burn probability is highest (except in interface); avoid lost silviculture investments Avoid treating areas in the WUI (increased fuel loading and crown bulk density).	Burn probability is lower; avoid lost silviculture investments. Treat areas outside of the WUI.
	Pruning	Increase crown base height. Pruned branches will increase surface fuel loading unless they are removed, or decay over time.		Burn probability is lower; avoid lost silviculture investments. High risk interface areas – provided surface fuel loading is reduced concurrent with the pruning treatment.
Rehabilitate	Knockdown and site preparation	Reduce fuel loading and eliminate crown fire risk (short term)		High risk interface area (3) identifies a need to treat fuels; mitigate risk
	Plant and brush	May have surface fire potential, depending on residual slash load	Burn probability is highest; avoid lost silviculture investments	

(1) This treatment may also increase crown fire potential in certain areas due to increased air flow through the stand. Care needed with surface fuel load and crown base height

(2) Higher surface fuel loading can result in more intense surface fires. Higher intensity surface fires have the potential to increase crown fire potential.

(3) Identified through a Community Wildfire Protection Plan (CWPP) or Provincial Strategic Threat Analysis (PSTA)

(4) Encourage deciduous or other fire-resistant species

(5) Intensity (I) is a function of the heat of combustion (H), weight of the fuel (W) and rate of spread of a fire (R) I=HWR

12 Habitat

12.1 Northern Goshawk

The existing and proposed northern goshawk (NOGO) WHAs were removed from the THLB in the IRMP Base Case and all the analysis scenarios. The IRMP Base Case was also set up to report on NOGO forage habitat; 2,500 m buffers (1962.5 ha) were placed around the centroid of NOGO nest clusters to represent forage areas. There was no provision for the discovery of future nests. The buffers were incorporated whether the nests were within WHAs or not. The amount of forage habitat was reported for each forage area. Two biodiversity scenarios tested the timber supply impact of imposing a 40 % and a 60% suitable forage habitat target within each forage area. Managing for NOGO foraging habitat had either no timber supply impact (40% target), or a small 2.8% negative impact in the long term (60% target).

The 40% target for each forage area was incorporated in the IRMP Selected Scenario as the desired management direction. While there is only limited area of potential forage area within the Arrowsmith TSA, the analysis indicates that it is possible to manage for NOGO forage habitat in the TSA without significant timber supply impacts.

12.2 Marbled Murrelet

The Marbled Murrelet (MAMU) is an important species in the TSA requiring old growth forest stands for its nesting habitat. A habitat suitability layer was provided for the analysis by the FLNR, West Coast Region. The East zone of the TSA contains little MAMU habitat as most of it is located in the West zone where 55% of the habitat is in the NHLB. Setting a habitat target at 68% for the West zone had no impact on timber supply. This suggests that the MAMU could be managed in that zone without significantly reducing the future harvest.

13 Colocation of Reserves and Constrained Areas

The Wildlife Habitat Areas (WHA) designation under FRPA, provides one of many legal means to manage habitat for regionally important wildlife and Species at Risk (SAR) in BC. Implementation of WHAs is guided by policy and procedures established through the Government Actions Regulation (GAR) Policy and Procedures (2013) and Identified Wildlife Management Strategy (IWMS) established in 1999 and amended in 2004.

An implementation plan and related socio-economic analysis form an important part of the WHA establishment process. Its intent is to ensure that the socio-economic impacts resulting from establishing a WHA do not exceed guidance provided by provincial policy.

In general, WHAs are expected to have a maximum of 1% timber supply impact by TSA. For some Species at Risk, such as Marbled Murrelet and Northern Goshawk, the provincial government has waived this requirement pending related land use decisions. Additional WHA designations are expected.

In 2015 the Chief Forester initiated the Provincial Stewardship Optimization/THLB Stabilization project. The intent of the project is to optimize placement of forest stewardship reserves while minimizing the timber supply impacts of these reserves and providing more stability for the Timber Harvesting Land-base (THLB). In practical terms, the intent is to find more efficient ways throughout the province to meet all the SAR requirements, and objectives for the 11 FRPA values. This can potentially be done by

investigating different combinations of locating the many constraints on timber harvesting. The primary objective is to improve stewardship while simultaneously providing stability to the THLB by optimizing the placement of spatial constraints (colocation), without changes in land use plans or legislation.

In practise, where colocation opportunities exist, they are often small in scale and may require site level review to ensure that the required habitat elements exist in proposed areas. For this reason, plans such as this IRMP can only investigate potential colocation opportunities at a landscape level.

13.1 Ungulate Winter Range

Harvesting does not occur in the Ungulate Winter Range (UWR) where the approved general management measure prohibits timber harvesting; the UWR is removed from the THLB in the netdown process. Approximately 655 ha of UWR do not currently overlap with any other THLB reductions in the Arrowsmith TSA. These areas are shown by landscape unit in Table 26.

Table 26: UWR with no overlap with other THLB reductions

Landscape Unit	Area (ha)
Chemainus	343
Cowichan	30
Effingham	13
Escalante	64
Henderson	63
Little Qualicum	19
Nanaimo	73
Toquart	51
Total	**655**

Colocation of the UWR with other constrained areas may provide opportunities to increase the THLB. Figure 12 illustrates an example from the Arrowsmith TSA where some UWRs overlap with OGMAs, while others are located near them creating a separate constraint/netdown. Colocation opportunities of UWRs should be investigated further in the field.

Figure 12: Example of potential colocation opportunities; UWR

13.2 Wildlife Habitat Areas

Approximately 507 ha of WHAs do not currently overlap with any other THLB reductions in the Arrowsmith TSA. As with the UWR, colocation of some WHAs with other constrained areas may provide opportunities to increase the THLB. These areas are shown by landscape unit in Table 27.

Figure 13 illustrates an example from the Arrowsmith TSA where MAMU WHAs overlap with draft OGMAs, while others are located near them creating a separate constraint/netdown. Colocation opportunities of WHAs should be investigated further in the field.

Table 27: WHAs with no overlap with other THLB reductions

Landscape Unit	Area (ha)
Chemainus	21
Effingham	2
Escalante	244
Loss	83
Nanoose	157
Total	**507**

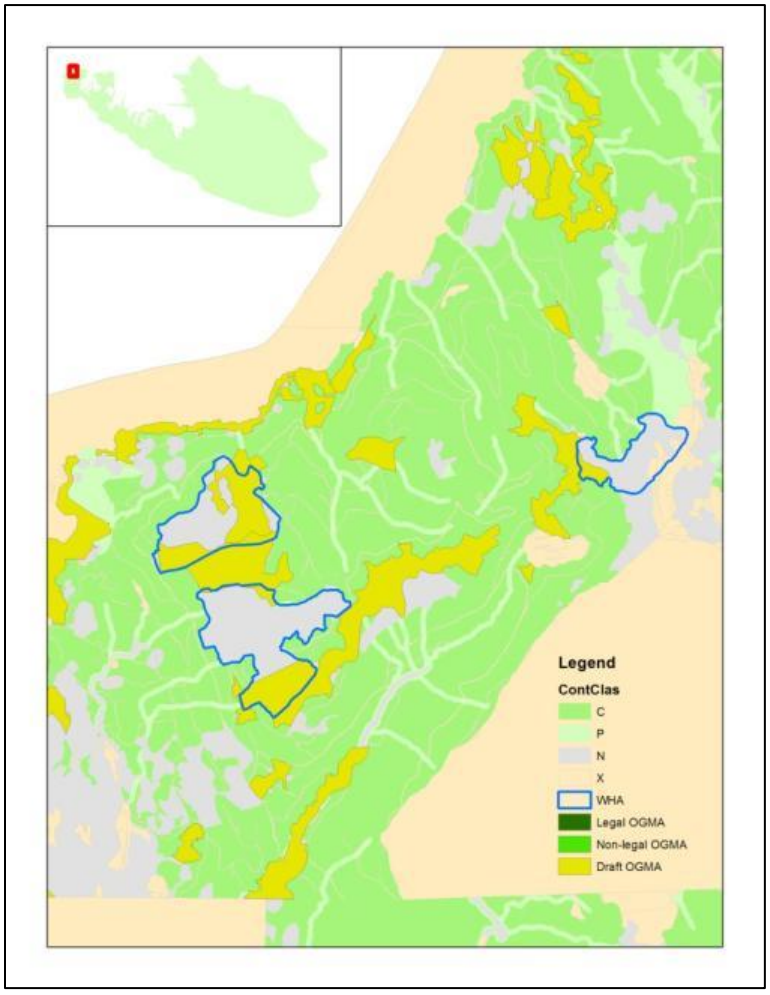

Figure 13: Example of potential colocation of MAMU WHAs

14 Conclusions

The preparation of the Arrowsmith TSA IRMP was a cooperative process with stakeholders identifying critical issues in the TSA and contributing to the strategy development to address those issues. The most significant conclusions are listed below:

- The IRMP Base Case development identified differences between current management and the way TSR defines current management, particularly with respect to the land base available for harvest:
  - ✓ Proposed area based tenures were incorporated in the analysis;
  - ✓ Ditidaht red zone was removed from the THLB;
  - ✓ Clayoquot Sound was excluded from the analysis;
  - ✓ Proposed NOGO WHAs and nests currently outside of WHAs were considered in the analysis;
  - ✓ Woodshed volume targets, woodshed based harvest deferrals were incorporated in the analysis.
- Many of the critical issues that we identified in the project relate to policy and/ or legislation. Policy and/or legislative changes are required; some critical issues cannot be addressed through strategic planning. Examples are:
  - ✓ Tenure Security;
  - ✓ Voluntary Deferrals;
  - ✓ Appraisal System;
- Better data are required to facilitate meaningful habitat modelling, particularly, at the landscape level.
- The fragmented nature of the TSA makes strategic planning difficult. Consideration should be given to strategic plans that encompass both the TSA and adjoining TFLs.
- Analysis scenarios tested a variety of feasible management strategies.
- The project found significant differences among management scenarios on impacts to various values, particularly projected $-value and overall harvest footprint.
- Chosen biodiversity indicators were generally not sensitive to inputs used in various scenarios.
- The IRMP Selected Management Scenario includes a relatively small incremental silviculture investment that is projected to lead to significantly higher long-term timber value while performing at least as well on non-timber values as the IRMP Base Case.
- Harvest assumptions must be followed to achieve the indicated outcomes.

15 Learnings and Recommendations

15.1 Ongoing process

The Arrowsmith IRMP is an on-going process. For some time the analysis file could be used to analyse the implications of proposed legal designations. For example, what impact will the draft Douglas-fir Ecosystem Land Use Order Amendment have on timber supply, habitat supply and other values?

15.2 Integration into adaptive management

There is an opportunity to integrate the IRMP into planning as part of the adaptive management process that incorporates monitoring results related to past harvest and silviculture investments to management. Furthermore, the implications of emerging issues and the effectiveness of potential management responses can be tested.

15.3 First Nations

While this process began by reaching out to First Nations in the TSA, their participation was limited. This iteration of the IRMP included an objective to maximize availability of cedar for traditional use.

The IRMP would benefit from the inclusion of a full range of First Nations values and First Nations' participation in selecting the harvest, retention and silviculture strategies.

Including First Nations representative as part of the planning team is desirable; however there remain challenges for inclusion, as there are 37 different First Nations in the TSA. This is an area that would benefit from Provincial direction.

15.4 Coordination with Forest Analysis and Inventory Branch

It was useful to work with the Forest Analysis and Inventory Branch (FAIB) in creating the base case and the analysis scenarios. Work between the analysts created a more robust analysis dataset and the data package, and allowed for sharing of ideas that would not have been available without the two processes running concurrently.

15.5 Use by District Staff

As the IRMP was a pilot, it took some time for the stakeholders to determine what the intended output would look like. The final report (strategy) will hopefully aid the district staff to articulate what expectations they have regarding the selected strategy and in focusing their efforts to support the achievable outcomes.

15.6 Co-location

Analyzing the colocation opportunities of reserves is not just intended to increase the area available for harvest, but to recognize that the expected distribution of harvest under current management, or other possible scenarios may create opportunities for new or revised reserve designs. For example, as expected harvest is predicted to have little impact on MAMU habitat in the TSA (areas mostly outside of

the THLB), the biodiversity value of these areas should be recognized and planning and related resources shifted to more challenging species/ecosystems.

15.7 Incorporation of Provincial Issues

It is important that as provincial issues emerge, there is recognition of those issues and how to incorporate them into a planning process such as the IRMP. For example, managing for carbon and the impacts of climate change have been identified as provincial issues and will benefit from future iterations of the IRMP.

15.8 Learnings for other TSAs

Some of the management problems are specific to this TSA and are caused by its disconnected land base. These problems and their potential solutions may not be transferable to more contiguous units. It is useful to highlight these problems for other areas with multiple tenures and private land within a specific area. An example would be the inability to understand implications of NOGO forage habitat, when not managing the entire forage area and not having access to the data for the adjoining areas.

Need for cooperation amongst licensees will become more acute, as more spatial licenses are created (e.g., First Nation Woodland Licenses).

As a TSA with a long harvest history and multiple resource management pressures, the IRMP provides a window on issues and potential solutions that may impact other TSAs in the future.

15.9 Forest Inventory and Other Inventories

It is often difficult to fully analyze and understand some management issues using a strategic resource inventory, as the data may not be collected to the level of interest. As an example, the project attempted to use fire threat ratings in the urban interface areas for treatment prescriptions. However, the fire threat ratings are based on the VRI, which in turn is not sufficiently detailed to provide direction on tactical treatments without field verification. A higher resolution, more tactical inventory would be beneficial for tactical planning.

15.10 Limitations of Growth and Yield Modeling

Data on the growth and yield modeling of mixed species managed stands is lacking, making estimates of future species compositions, yields and timber values problematic. The use of TASS, which incorporates some stand dynamics for mixed species stands and allows the simulation of stands with both planted and natural trees (vs TIPSY[4] which, does not include any stand dynamics and does not accommodate modeling of stands with planted and natural components), while helpful was time consuming.

Future iterations should take the learnings from the use of TASS (as described in detail in the Modelling and Analysis Report) and of the importance of the development of managed stand analysis units and their attributes from available data.

[4] https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/table-interpolation-program-for-stand-yields-tipsy

An improvement would be to incorporate BEC data into the development of analysis units, as this ecological framework is strongly tied to management and natural processes.

The level of post-harvest retention in the landscape and its impact on growth and yield is poorly understood. Both this project and the latest TSR revealed the need for monitoring the retention levels throughout the TSA. Also, monitoring of growth and yield impacts of moderate and high level of retention is required.

15.11 Challenges to implementation of the Selected Strategy

15.11.1 Value or Volume

This project identified the need to address the issue of value versus volume as a specific objective from a provincial and localized perspective. While the selected management strategy in this IRMP emphasizes actions that favor the long - term value of the harvested timber, the implementation of this strategy may be difficult due to increased upfront costs and the perceived beneficiary of the long term benefits. There needs to be clear provincial direction on the use of provincial funding for creation of added value beyond the present approach.

15.11.2 Challenges for Implementation

There are significant challenges to successful implementation of many components of this strategy under the current forest management framework in British Columbia (stumpage appraisal, tenure and regulatory systems). The Crown (the people of BC/government) owns the resource and has passed the responsibility for much of its management to timber tenure holders, including the timing and location of harvest, and basic reforestation.

This system provides for efficient harvest scheduling and timely reforestation with ecologically suitable tree species; however it does not promote long - term investments by the tenure holders. Furthermore, the current forest management framework can make it difficult for government to invest effectively in incremental silviculture regimes (a series of treatments that span the whole rotation) to meet integrated objectives without appropriate changes in policy.

For example, on areas primarily designated for timber production, the Arrowsmith IRMP Selected Management Strategy recommends investments in enhanced basic reforestation of sites that are ecologically suitable for management of Cw, followed by juvenile spacing and potentially fertilization. Analysis showed that this regime could contribute to a substantial improvement in the value recovered from the timber harvest over the longer term, if the treated stands were not harvested too soon.

The key to achieving the benefits of this strategy require investments in basic silviculture, spacing and fertilization and that harvesting occurs within a certain age range (generally longer than minimum harvest age). The government does not currently have means to direct investments in enhanced basic reforestation on the Coast, nor does it control the time of harvest.

15.11.3 Following the plan

The implementers of this plan may be tempted to take the figures and specific direction from this strategy and accept them as a “rule”. Rather, they are conceptual and should be taken as guidelines when developing tactical harvest schedules or tactical silviculture treatment plans.

The higher level harvest direction and findings are important. The east/west timber profile and its harvest as per the profile is necessary. The same applies to the harvest of the helicopter/conventional timber profile currently included in the THLB.

The projected harvest by woodshed is less important in that the same timber supply may be accomplished by harvesting less timber in one woodshed than projected and more in another. The first step when reviewing the harvest strategy by woodshed is to assess the tactical feasibility of the recommended harvest.

15.12 Recommendations

- Greater First Nation's involvement.
- Establish local timber objectives with licensees to facilitate the achievement of the harvest strategy.
- Advocate for and develop a TSA-wide tactical plan with licensees to guide the achievement of the harvest and silviculture strategies.
- The IRMP should be used to help inform local incremental silviculture investment opportunities developed as part of the Coast Area Integrated Investment Plan.
- Develop policy proposal for appraisal manual change to allow for enhanced basic reforestation (e.g., increased planting density of Cw). Alternatively look for incremental funding opportunity (e.g., FFT or FESBC for Carbon) for increased Cw planting density.
- Develop FESBC or FFT proposal to look for opportunities for spacing of Cw plantations overtopped by hemlock ingress.
- Develop policy proposal for appraisal manual changes to promote stump removal in root disease areas as a specified operation with accurate cost assessment.
- Work with Forest Analysis and Investment Branch to look for modifications to TSR based on the IRMP Base Case approach.
- Better integration of additional landscape level fire management planning – e.g., where to use fire stocking standards, where to place fire breaks. This will require involvement of other landowners.
- Improve ties to provincial and regional Cumulative Effects initiatives This could include:
    - ✓ Aligning IRMP indicators with cumulative effects values
    - ✓ Incorporating cumulative effects thresholds as IRMP management objectives
    - ✓ Providing landscape forecasting support for cumulative effects teams
    - ✓ Reporting on implications of cumulative effects values and thresholds on timber supply
- More access to LiDAR and photo imagery will be useful in translating strategic direction to tactical planning.
- Tie all future funded treatments to a risk assessment approach and mapping as described in the Silviculture Strategy.
- Where possible, recommended treatments should be identified in a manner that they can be clearly articulated for funding sources to promote implementation.

- A monitoring plan for implementation is needed to track whether the assumptions provided in this strategy promoting the desired outcomes are being followed. If not, the reasons for not following the assumptions must be understood and addressed.
- The IRMP Base Case was created to show a more flexible understanding of available timber supply. There is a desire from district staff for the analysis to use additional sensitivity analyses or scenarios to demonstrate the "looking forward" current practice elements that make the IRMP different from the TSR.

16 List of Acronyms and Tree Species Codes

16.1 Acronyms

Acronym	Description
AAC	Annual Allowable Cut
BCGW	BC Geographic Warehouse
BCLCS	BC Land Classification System
BCTS	BC Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BMTA	Biodiversity, Mining, and Tourism Area
CDC	Conservation Data Centre
CFLB	Crown Forested Land Base
CNCO	Central and North Coast Order (EBM)
DBH	Diameter at Breast Height
DCR	Campbell River Natural Resource District
DIB	Diameter inside bark
DKM	Coast Mountains Natural Resource District
DNI	North Island Central Coast Natural Resource District
DRS	Draft Recovery Strategy for Northern Goshawk
DSC	Sunshine Coast Natural Resource District
DSI	South Island Natural Resource District
EBM	Ecosystem Based Management
ECA	Equivalent Clearcut Area
ESA	Environmentally Sensitive Area
EXLB	Excluded Land Base
FAIB	Forest Analysis and Inventory Branch, Ministry of Forests, Lands, and Natural Resource Operations
FC1	Former Forest Cover Inventory Standard
FESL	Forest Ecosystem Solutions Ltd.
FLNR	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FMLB	Forest Management Land Base
FPPR	Forest Planning and Practices Regulation
FRPA	Forests and Range Practices Act
FSOS	Forest Simulation and Optimization System (model used for analysis)
FSW	Fisheries Sensitive Watershed
GAR	Government Action Regulation
GBRO	Great Bear Rainforest Order (EBM)
GIS	Geographic Information Systems
HVFH	High Value Fish Habitat
IRM	Integrated Resource Management
LRMP	Land and Resource Management Plan
LU	Landscape Unit
LUOCS	Landscape Unit Order Clayoquot Sound

Acronym	Description
MAMU	Marbled Murrelet
MOE	Ministry of Environment
MSYT	Managed Stand Yield Table
NCBR	Non-Commercial Brush
NHLB	Non-Harvesting Land Base
NHVFH	Non-High Value Fish Habitat
NOGO	Northern Goshawk
NRL	Non-recoverable Losses
NSR	Not Sufficiently Restocked
NTA	No Typing Available
NSYT	Natural Stand Yield Table
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Area
PEM	Predictive Ecosystem Mapping
PSP	Permanent Sample Plot
RMA	Riparian Management Area
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
SCCO	South Central Coast Order (EBM)
SIBEC	Site Index by BEC Site Series
SMZ	Special Management Zone
SRMP	Sustainable Resource Management Plan
SSG	Site Series Grouping
TASS	Tree and Stand Simulator
TEM	Terrestrial Ecosystem Mapping
TFL	Tree Farm License
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation for Stand Yields
TSA	Timber Supply Area or Timber Supply Analysis
TSG	BCTS Strait of Georgia Business Area
TSK	BCTS Skeena Business Area
TSR	Timber Supply Review
TST	BCTS Seaward/Tlasta Business Area
UWR	Ungulate Winter Range
VAC	Visual Absorption Capability
VDYP	Variable Density Yield Projection
VEG	Visually Effective Green-up
VILUP	Vancouver Island Land Use Plan
VRI	Vegetation Resource Inventory
VQO	Visual Quality Objective
WHA	Wildlife Habitat Area
WTRA	Wildlife Tree Retention Area

16.2 Tree Species Codes

Species Code	Species Name
Ba	Amabilis fir
Cw	Western redcedar
Fd	Douglas fir
Dr	Red alder
Hm	Mountain hemlock
Hw	Western hemlock
Pl	Lodgepole pine
Pw	Western white pine
Ss	Sitka Spruce
Yc	Yellow cedar/Cypress

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