TABLE OF CONTENTS

Tables

1.0 Executive Summary

Parsons and Associates, Inc. has reviewed the data available and chosen an Area Control model to calculate the Periodic Sustained Yield (PSY) from the State of Alaska managed forest lands in the Tanana Valley. The results of these calculations are as follows:

Periodic Sustained Harvest for Regulation by Management Area (10 year period)			
Management Area	**Total Managed Acres**	**Periodic Harvest Acres**	**Periodic Harvest Volume (mcf)**
Kantishna	538,319	62,450	119,496
Fairbanks	538,877	62,585	134,252
Delta	485,599	54,711	122,843
Tok	334,283	35,396	44,492
Total	1,897,078	215,141	421,084

2.0 Scope of Project

Parsons & Associates, Inc. (P&A), an Alaska Corporation, has been contracted by the State of Alaska, Department of Natural Resources (ADNR), Division of Forestry (DOF) to calculate the potential PSY of timber available from the Tanana State Forestry Lands. The PSY calculation for this project will be based on previously collected timber inventory data provided by the DOF. Field verification of the existing inventory data is beyond the scope of this analysis, and P&A has made no attempt to verify the accuracy of the data provided by the ADNR.

In order to determine an appropriate rotation age, P&A would evaluate existing forest growth data and models applicable for the commercial timber species prevalent in the Tanana State Forestry Lands. P&A has reviewed the works of Daniel Weiczorek, two thesis prepared by graduate students at the University of Alaska Fairbanks, and U.S. Forest Service inventory documents. In addition to published studies, P&A has conducted personal interviews with Edward Packee, Ph.D., Professor of Forestry at the University of Alaska Fairbanks, and Steve Clautice of the ADNR DOF. The results of this research form the basis for assumption values used in determining the Periodic Sustained Yield (PSY).

The goal of this project is to evaluate inventory data from the four management units that comprise the Tanana State Forestry Lands, and calculate a biological PSY for each unit. The management units evaluated were the Kantishna, Fairbanks, Delta, and Tok management areas. The acres contained within these management units constitute the portion of state land in the Tanana Valley designated for forest management. Evaluating and calculating the PSY by management area takes into account variations in climatic conditions, available nutrients, soil composition, and site index, which are unique to each management unit. These geographic variables significantly affect the growing characteristics of the commercial

timber species present within each management unit. Consequently, to accurately estimate the PSY for the project area, each management unit will be analyzed independently of the other management units.

The base data for calculating the PSY is presented in the June 1997 *Timber Resources of State Forestry Lands in the Tanana Valley* (Crimp report) prepared for ADNR by Crimp, Phillips, and Worum. After reviewing this data, P&A was to determine the best method of analyzing inventory data to calculate a scientifically acceptable PSY. The methods available for calculating the PSY ranged from a simple area-control equation, to incorporating computer modeling using linear programming optimization formulas. The level of sophistication used in calculating the PSY is dependent upon the level of statistically significant growth and inventory data available.

The result of the PSY calculations will include the acres available for harvest, cubic foot harvest volume, and an estimate of board foot (bf) spruce sawlog volume that may be harvested within a given management area during a 10-year period. Presenting the results based on a ten-year period as opposed to estimating SY on an annual basis allows managers to tailor harvest planning around economic and climatic constraints, while still meeting land management objectives.

Throughout the performance of this project, P&A was directed by ADNR contract to use existing research and field data previously collected or developed to perform these calculations. P&A will accept the base data from the DOF as correct and will not attempt to verify either acres, existing inventory volumes, or documented annual growth rates. No field verification for species composition would be affected as part of this contract.

3.0 Assumptions

In order to perform the proposed calculations and estimations, certain assumptions will be necessary. P&A will use the Crimp Report to provide the base data for performing the calculation contained within this report.

3.1 Acres

The number of acres presented in the Crimp report are assumed to be correct and accurately represents the number of acres of manageable forestland within each management unit. P&A will also assume that all acres described in the inventory report are available and designated for forest management by the ADNR/DOF.

The total number of acres comprising each management area is presented in Table 5, page 19, of the Timber Inventory report. Table 5 also summarizes all of the manageable acres available within each management area by timber type and strata.

For the purposes of this report, the number of acres shown in Table 5 of the Crimp Report will be used as the gross acres of forested land available for timber management. P&A has

selected the term"gross acres" due to the number of acres contained within vegitation types and strata that, with the manufacturing technologies available, do not contain species currently classified as having commercial value. With changing technologies, these species may become commercially viable and are thus part of the acres designated for forest management, but will not be included in the PSY calculations contained in this report. Deletion of these acres containing presently non-commercial species represents an accurate snapshot of current timberlands available for management, and calculates a conservative PSY.

Table 1, below, summarizes the acres available for management by management area and vegitation type.

Table 1
Forestland Acres by Vegetation Type

Vegetation Type	Management Area				Total
	Kantishna	Fairbanks	Delta	Tok	
White Spruce	28,301	20,508	24,902	42,720	116,431
Poplar/Spruce	20,745	15,132	12,074	8,890	56,841
Black Spruce	246,660	232,550	219,642	216,587	915,438
Hardwood/Spruce	327,691	337,522	338,215	250,635	1,254,062
Hardwood	201,082	202,933	143,520	45,907	593,442
Total	824,480	808,645	738,352	564,738	2,936,214

Source: Crimp report

3.2 Black Spruce Type

Although the number of acres shown in Table 1 represents the total number of forested acres within the individual management units, it does not represent the number of acres that will be considered manageable for the purposes of this report. After discussions with the DOF, P&A has removed the acres delineated as a black spruce (Picea mariana) from the number of acres available for managment. Acres representing the black spruce vegetation type, as well as those acres designated as black spruce within the other vegetation types will be deleted from the total acres to arrive at the number of acres managed for timber production. As stated previously, these acres are being removed due to the lack of economically viable processing technologies for converting black spruce to a commercial product. As the necessary technologies become available, these acres should be added back into the acre pool and a revised PSY value calculated.

Table 2 illustrates the acres that will be removed, due to the current lack of a commercial processing facility, from the original Table 5 in the Crimp report accounting for the acres of black spruce removed from the pool of manageable acres. The deleted acres are contained

within the parenthesis. Total acres removed are from each strata are summarized by management unit and an overall total calculated at the end of Table 2.

Table 2
Proposed Acre Reduction

Vegetation Type	Strata*	Management Area				Total
		Kantishna	Fairbanks	Delta	Tok	
White Spruce	1	17,787	11,603	8,964	3,153	41,508
	2	10,514	8,905	15,938	39,567	74,924
	Total Deleted					
Poplar / Spruce	5	1,423	292	--	498	2,213
	6	5,432	4,101	2,281	1,226	13,040
	11	3,236	2,517	609	1,651	8,014
	12	6,591	3,205	4,688	3,153	17,638
	23	2,686	3,698	2,986	1,346	10,716
	27	1,377	1,318	1,509	1,016	5,220
	Total Deleted					
Black Spruce	3	**(3,394)**	**(9,717)**	**(3,871)**	**(3,885)**	**(20,867)**
	4	**(225)**	**(1,346)**	**(1,835)**	**(406)**	**(3,812)**
	20	**(82)**	**(4,902)**	**(22,809)**	**(23,036)**	**(50,829)**
	21	**(3,504)**	**(22,605)**	**(43,953)**	**(41,274)**	**(111,336)**
	22	**(239,455)**	**(193,979)**	**(147,174)**	**(147,986)**	**(728,594)**
	Total Deleted	**(246,660)**	**(232,549)**	**(219,642)**	**(216,587)**	**(915,438)**
Hardwood Spruce	8	19,794	18,987	3,732	2,789	45,303
	9	63,971	123,254	128,946	113,802	429,972
	10	**(39,501)**	**(37,218)**	**(33,111)**	**(13,867)**	**(123,698)**
	25	7,576	54,729	55,629	53,730	171,665
	26	196,848	103,334	116,796	66,445	483,423
	Total Deleted	**(39,501)**	**(37,218)**	**(33,111)**	**(13,867)**	**(123,698)**
Hardwood	7	163,351	134,269	115,292	16,058	428,970
	24	37,732	68,665	28,228	29,848	164,472
	Total Deleted					
Total Deleted Lands		**(286,161)**	**(269,767)**	**(252,753)**	**(230,454)**	**(1,039,135)**

Data derived from Table 5 of the Crimp report.

The small diameter of black spruce makes it of little value for the manufacture of commercial lumber. The dark color of black spruce in combination with a high resin content often makes it undesirable for pulp production. This is not always the case, however. Since black spruce is a major component of pulp production in Manitoba where kraft papers are produced. Black spruce colonization is common in areas of eutrophication. Black spruce, due to its prolific seed crop, is often the first woody species to become established in burned-over areas or as a pioneer species on better growing sites.

According to the *"Alaska Trees and Shrubs"* Agriculture Handbook 410:

> *Black spruce is characteristic of cold wet flats, muskegs, north facing slopes, silty valley terraces, and lake margins in the spruce-birch interior forest up to an altitude of 2,000 ft. (610m.), locally to 2,700 ft. (823m.).*

Presently, the markets into which Alaskan timber is sold can use only small percentages of black spruce. Consequently, black spruce is a non-commercial species with regard to the current markets and production technologies. As markets change or technologies capable of using significant volumes of black spruce become available to the Alaskan forest products industry, black spruce and its associated acres will need to become part of the PSY calculation.

3.3 Rotation Age

According to the Society of American Foresters (1955) rotation is defined as "the period of years to establish and grow timber crops to a specified condition of maturity." Hursh, Miller & Beers in the Second Edition of "*Forest Mensuration*" 1972, define rotation as "…the period of years that elapse between the formation of a stand of timber and the time when it is ready for cutting and regeneration." For the purposes of this report, P&A has elected to use previously established rotation ages for hardwoods as found in the Wieczorek report. As stated by Wieczorek:

> *It is not felt that a significant increase in cubic volume per acre would occur by letting the hardwoods reach sawlog size. It was found in the Inventory data that sawlog size hardwood stands are practically non-existent.*

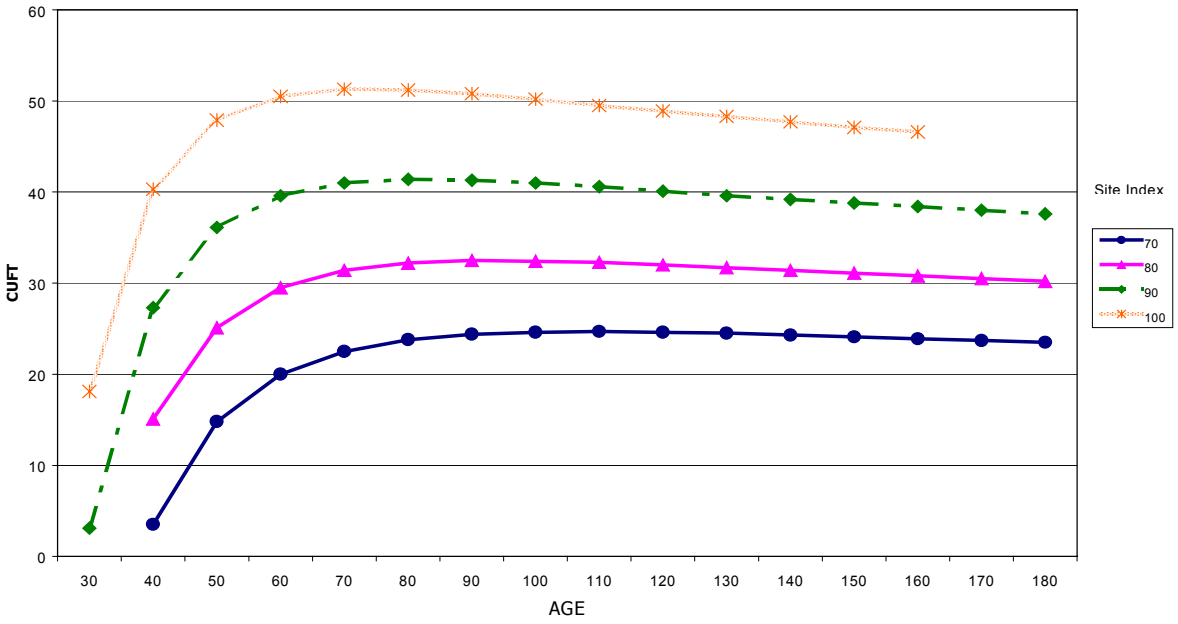
In contrast, the Rotation Age proposed in the Wieczorek report significantly underestimates the PSY of white spruce on the Tanana Valley lands. According to Wieczorek, a spruce rotation age of 120 years has been proposed. Wieczorek analyzed four methods of determining Rotation Age. Two methods estimate a Rotation Age of approximately 100 years plus 10 years for establishment, and two estimated 120 years as the appropriate age. As shown in Figure 1, the culmination of mean annual increment estimates that the biological rotation age would be between 60 and 80 years, excluding 12 years for establishment. For the purposes of this report, establishment is defined as the time necessary for a tree to obtain a diameter at breast height (dbh).

The values listed below are supported by previously published reports, and have been used as the basis for previous analysis of the Tanana State Forestry Lands. For the purposes of this report, P&A will accept the values listed below as the rotation ages. These rotation ages do not include a period for establishment.

White Spruce (picea glauca)	100 years
Hardwoods	70 years

These rotation periods are significantly longer than rotation ages derived by using the culmination of mean annual increment. By graphing data available from the Pacific Northwest Experiment Station, shorter rotation ages can be established based upon culmination of periodic increment or biological maturity. As shown in Figure 1, culmination data indicates that white spruce grown on an acre of land with a site index of 70 could be harvested in approximately 80 years. This assumes that the timber is managed to produce fiber and not sawlog material. Allowing the white spruce stands to mature for an additional 20 years will allow the standing timber to attain a dbh of approximately 12.5 inches on site index 70 lands. This diameter is sufficient to produce sawn products and meet the needs of the existing timber industry that relies on the Tanana State Forestry lands for its raw material. Extension of the rotation age beyond the age of biological maturity provides a conservative estimate of the periodic volume available for harvest.

Figure 1
Mean Annual Increment (cuft)



Source : Growth and Yield of Well-Stocked White Spruce Stands in Alaska PNW-53

Due to the current status of the timber processing industry, P&A will continue to use the established rotation age of 100 years for white spruce. However, as engineered wood technologies become available within the state of Alaska, these managed rotation ages should be revisited and a new PSY value calculated.

In Figure 1, the culmination of mean annual increment is the point on the graph where the growth curve ends its exponential rise and begins to flatten. For a site index of 70 (the

lowest curve) culmination is achieved during the 80-year growth period. As the site index increases, culmination is shortened (moves farther to the left). Site index in the Tanana Valley range from 70 to 100.

Using 12 years to reach establishment, according to field observation, appears to artificially lengthen the rotation period and add to the conservative nature of the PSY estimates calculated for this report. Additional reduction of rotation age can be accomplished through the implementation of an aggressive regeneration program. Implementation of this program could reduce the rotation period by 6 years. As additional data becomes available, reflecting the affects of intensive forest management techniques on the time necessary for trees to obtain dbh, a revised PSY value should be calculated. Intensive forest management will initiate the necessary step to enable the regenerated forest to successfully compete with grass and brush species, which normally inhibit the growth of the regenerated forest. By scarifying and planting nursery stock seedlings, the new forest can out-compete shrubs and grasses than would normally compete for the nutrients and available water available and become established before the desired forest species. Photographs contained in the Appendix show the ability of nursery stock to out-compete shrubs, grasses and other hardwoods. Using this assumption, the rotation ages shown in Figure 1 are conservative, but applicable for this analysis.

3.4 PSY Model

Multiple SY models exist which might be used to determine the PSY for the Tanana State Forestry Lands management areas. Most of these models assume a certain level of previous management, and some require that the managed forest be under some form of regulation. Since the lands contained within the four management areas are primarily over-mature; and have experienced little or no significant management activity; P&A assumes (that for the first rotation) the silvicultural goal is bringing the managed lands under regulation.

According to Davis in the second edition of Forest Management, the concept of forest regulation can be described as follows:

> *The essential requirements of a fully regulated forest are that age and size class be represented in such proportion and be consistently growing at such a rate that an approximately equal annual or periodic yield of products of desired size and quality may be obtained.*

Simply stated, a consistent flow of predetermined timber products from a dedicated tract of land on an annual or periodic basis. For the purposes of this report, P&A has determined sustained harvest on a periodic basis. The period will be one decade or ten years. Basing harvest levels on a periodic basis allows for market fluctuation and natural disasters that may inhibit implementation of the desired silvicultural prescription.

Two methods of control are available for determining PSY on state lands within the Tanana Valley. The first is area control. This method divides the number of acres within a timber type by the applicable rotation age. This provides the number of acres to be treated to bring the forest under regulation after one rotation period. The other method is volume control. This method accounts for growth within the rotation period and more accurately reflects the interaction of site index and stand composition to derive PSY values. The volume control method for determining PSY requires statistically significant growth data and species composition information.

According to Davis and Johnson, "area control is the easiest way to regulate an unmanaged forest and guarantee that the regulated structure is attained within one rotation." Due to the existing unregulated nature of the standing timber within the four management areas, and the lack of statistically accurate growth data for all strata that compose the various vegetation types within each management unit, P&A has used area control for the primary estimation of PSY for the Tanana State Forestry Lands.

For informational purposes, P&A has calculated a PSY using the Von Mantel formula. Von Mantel's formula attempts to account for growth within the rotation period by using total volumes present within a given vegetation type, and dividing that volume by one half of the rotation age. Estimates using Von Mantel's formula are presented for informational purposes only. The PSY calculated by this method will be used to compare and to provide verification for the area control method.

More sophisticated models are available once additional growth data are collected and analyzed. For the initial conversion of a forest comprised primarily of over-mature timber, to one that maintains a predictable and non-declining supply of forest products, the area control model is the simplest method of bringing commercial timberlands under regulation within one rotation period.

4.0 Process

4.1 Acreage Determination

The first step in completing the PSY calculation was determining the precise number of acres for inclusion. For the purposes of this report, P&A has accepted the acres determined by the ADNR/DOF as accurate. The DOF has assigned acreage values for each vegetation type within each management unit. These acreage values will form the basis for the area control calculation.

Since available data describes acres by vegetation type, determining which acres to include in the calculation drives the remaining steps of the PSY calculation. As discussed in Section 3.1, only those acres containing commercial timber species were to be included.

Commercial species include white spruce (*Picea glauca*), paper *birch (Betula papyrifera*), balsam poplar (*Populus balsamifera*), and quaking aspen (*Populus tremuloides*).

Table 3 presents the number of acres for inclusion in the PSY calculation after deleting the black spruce vegetation type from each management area and the black spruce component within a vegetation type in a management area.

Table 3
Final Acre Table

Vegetation Type	Strata	Management Area				Total
		Kantishna	Fairbanks	Delta	Tok	
White Spruce	1	17,787	11,603	8,964	3,153	41,508
	2	10,514	8,905	15,938	39,567	74,924
	Total	28,301	20,508	24,902	42,720	116,431
Poplar / Spruce	5	1,423	292	--	498	2,213
	6	5,432	4,101	2,281	1,226	13,040
	11	3,236	2,517	609	1,651	8,014
	12	6,591	3,205	4,688	3,153	17,638
	23	2,686	3,698	2,986	1,346	10,716
	27	1,377	1,318	1,509	1,016	5,220
	Total	20,745	15,132	12,074	8,890	56,841
Hardwood/ Spruce	8	19,794	18,987	3,732	2,789	45,303
	9	63,971	123,254	128,946	113,802	429,972
	25	7,576	54,729	55,629	53,730	171,665
	26	196,848	103,334	116,796	66,445	483,423
	Total	288,189	300,304	305,103	236,767	1,130,364
Hardwood	7	163,351	134,269	115,292	16,058	428,970
	24	37,732	68,665	28,228	29,848	164,472
	Total	201,082	202,933	143,520	45,907	593,442
All Forested Land		538,319	538,877	485,599	334,283	1,897,078

4.2 Determination of Rotation Age

Several complicated formulas exist that could be used to determine the appropriate rotation age or period for the various vegetation types. If accurate and statistically significant growth data, site index information, species mix, and age classification were available, a specific rotation period could be calculated using a weighted-value method. However, this data is not available, and its calculation is beyond the scope of this project. In order to arrive at a value that is useful to the ADNR/DOF forest managers, P&A has requested that certain management criteria be made available and used as a given for this exercise.

According to the management information provided by the ADNR/DOF, mixed stands of hardwoods and white spruce will be managed for the white spruce component, and pure hardwood vegetation types will be managed on a hardwood rotation. Visual inspection of mixed hardwood and white spruce stands lends credence to this decision. Based on a walk-through inspection, a significant portion of the white spruce/balsam poplar and the white spruce/mixed hardwoods contained understory white spruce that will overtake and convert the vegetation type to white spruce as the stand reaches biological maturity. This is also seen in the regenerated forests. Photographs of these observations are included as an appendix to this report.

Based on this information, the following rotation periods will apply to the various vegetation types:

Table 4
Rotation Age

Vegetation Type	Rotation Period
White Spruce	100 years
White Spruce/Balsam Poplar	100 years
White Spruce/Mixed Hardwoods	100 years
Hardwoods	70 years

4.3 Formula for Area Control

To calculate the area to be harvested on a periodic basis to bring the Tanana State Forestry Lands under regulation, the applicable rotation age is divided into the number of acres associated with each vegetation type within each management area. The results of these calculations will determine the number of acres within each vegetation type that must be harvested per 10-year period to meet the area control parameters. The results of each vegetation type are summed by management unit to determine the total number of acres available for treatment per decade within each management unit.

The formula is as follows:

$$\sum_{t=i}^{j}\left(\text{ACRES}_{(VT)}/\text{RP}\right) = \text{Treatment Acres}_{(MU)}$$

where:
t = the starting vegetation type RP = rotation period
J = total number of vegetation types within a management unit
$\text{ACRES}_{(VT)}$ = total managed acres within a vegetation type
$\text{Treatment Acres}_{(MU)}$ = total acres to be treated per 10-year period

Example: Kantishna White Spruce

(28,301acres/100 year rotation * 10 year/period * 3,045 cf/acre)/1000 = 8,618 mcf/period

While this appears to be a simple formula which accounts for only a limited number of the variables which contribute to the estimation of acres available for treatment, it does form the basis for bringing a previously unregulated forest under regulation. Forest managers will need to take caution in designing the silvicultural treatments to ensure an even flow of products from the forest while it is being brought under regulation. According to Davis and Johnson in the third edition of *Forest Management*,

> *Applied to a forest that is initially irregular in age class structure or site, area control can yield a fluctuating timber harvest volume and size while regulation is being achieved.*

Decisions regarding treatment schedules are beyond the scope of this project. This report provides only a biological capacity of the lands discussed, based upon the pertinent data available from the Crimp report.

4.4 Volume per Acre

In order to provide managers with a clear picture regarding management prescriptions, P&A will convert the acres determined by the process described in Section 4.3 into volumes. P&A will provide the initial findings in *net thousand cubic feet (mcf)* and will later convert the proposed spruce volumes into *net thousand board feet (mbf).* Volumes provided by the ADNR/DOF will be used to convert the acre values into volumes. The volumes per acre are based on the mature timber and differ from those found in Tables 7-10 of the Crimp report. The Crimp report uses volumes on all acres without regard to maturity. Consequently, those acres that are comprised of seedling and sapling stage timber reduce the average volume of the timber that will be scheduled for harvest during this conversion to a regulated forest.

The values that will be used are specific to vegetation type and management unit. Each vegetation type contains several strata, and often there is more than one strata of pole or sawtimber size. The actual acreage harvested in the past from each stratum was used to calculate a weighted volume per acre for vegetation types. The values used to calculate the conversion from area to volume are contained in Table 5.

Table 5
Volumes per Acre

Vegetation Type	Weighted Volume per Acre (cft)			
	Kantishna	Fairbanks	Delta	Tok
White Spruce	3045	3460	3145	2309
Poplar/Spruce	2189	1936	1891	3192
Hdwd/Spruce	2404	2790	2506	1138

Hardwood	1290	1395	1769	739

5.0 Calculation Results

5.1 Periodic Sustained Yield by Management Unit and Vegetation Type

Table 6 provides a summary of the calculated PSY for the Tanana Valley State Forestry Lands.

Table 6
Management Unit PSY by Vegetation Type

Vegetation Type	Seed / Sap	Pole	Saw	Total Acres	Rotation (years)	Periodic Acres (10 yrs)	Volume / Acre (cf)	Periodic Volume (mcf)
Kantishna								
White Spruce	--	10,514	17,787	28,301	100	2,830	3045	8,618
Poplar/Spruce	4,063	12,023	4,659	20,745	100	2,075	2189	4,541
Hardwood/Spruce	204,424	63,971	19,794	288,189	100	28,819	2404	69,281
Hardwood	37,732	163,351	--	201,082	70	28,726	1290	37,057
Total	246,219	249,859	42,240	538,319		62,450		119,496
Fairbanks								
White Spruce	--	8,905	11,603	20,508	100	2,051	3460	7,096
Poplar/Spruce	5,016	7,306	2,809	15,132	100	1,513	1936	2,929
Hardwood/Spruce	158,063	123,254	18,987	300,304	100	30,030	2790	83,785
Hardwood	--	134,269	68,665	202,933	70	28,990	1395	40,442
Total	163,079	273,734	102,064	538,877		62,585		134,252
Delta								
White Spruce	--	15,938	8,964	24,902	100	2,490	3145	7,832
Poplar/Spruce	4,495	6,969	609	12,074	100	1,207	1891	2,283
Hardwood/Spruce	172,425	128,946	3,732	305,103	100	30,510	2506	76,459
Hardwood	28,228	115,292	--	143,520	70	20,503	1769	36,270
Total	205,148	267,145	13,306	485,599		54,711		122,843
Tok								
White Spruce	--	39,567	3,153	42,720	100	4,272	2309	9,864
Poplar/Spruce	2,362	4,379	2,149	8,890	100	889	3192	2,838
Hardwood/Spruce	120,176	113,802	2,789	236,767	100	23,677	1138	26,944
Hardwood	29,848	16,058	--	45,907	70	6,558	739	4,846
Total	152,386	173,806	8,091	334,283		35,396		44,492

5.2 Volume by Species

Table 7 provides a breakdown of the volume, by species that will be harvested under the area control model. The proportions used in constructing this table were calculated using data from Table 12, page 26, of the Crimp report.

Table 7a
Proportional Harvest Volume by Species

Management Area	Periodic Volume	White Spruce	Black Spruce	Tamarack	Paper Birch	Balsam Poplar	Aspen	Total Volume
Kantishna	119,496 (mcf)							
Species %		39.7	2.6	0.1	39.6	2.7	15.3	100
Volume (mcf)		47,429	3,147	127	47,279	3,235	18,280	119,496
Fairbanks	134,252 (mcf)							
Species %		42.4	6.5	0.0	31.8	2.8	16.6	100
Volume (mcf)		56,880	8,687	5	42,629	3,809	22,241	134,252
Delta	122,843 (mcf)							
Species %		46.1	2.6	0.1	34.1	5.4	11.7	100
Volume (mcf)		56,668	3,135	80	41,948	6,678	14,335	122,843
Tok	44,492 (mcf)							
Species %		68.0	7.0	0.0	11.0	2.2	11.8	100
Volume (mcf)		30,263	3,128	0	4,883	979	5,240	44,492
	Total	191,240	18,097	212	136,739	14,700	60,096	421,084

Table 7b
White Spruce Sawlog Volume (mbf)

Management Area	W.Spruce Volume	Kantishna	Fairbanks	Delta	Tok	Total Volume
	Volume (mcf)	47,429	56,880	56,668	30,263	191,240
	Volume (mbf)	190,570	228,540	227,690	121,600	768,400

The calculation for converting cubic feet to board feet is taken directly from the work done by Weiczorek in June of 1980. To convert cubic feet to board feet one simply multiplies the number of cubic feet by 4.018 to determine the volume in board feet.

Example:

47,249 mcf of white spruce X 4.018 bf/ cf = 190,570 mbf

5.3 Project Summary

Table 8
Area Control Summary

Sustained Harvest for Regulation by Management Area			
Management Area	**Total Managed Acres**	**Periodic Harvest Acres**	**Periodic Harvest Volume (mcf)**
Kantishna	538,319	62,450	119,496
Fairbanks	538,877	62,585	134,252
Delta	485,599	54,711	122,843
Tok	334,283	35,396	44,492
Total	1,897,078	215,142	421,084

6.0 Volume Control

6.1 Von Mantel

Von Mantel's formula provides the best estimate of volumes available, using the currently available data, for removal under a volume control model. The information provided in the Crimp report is well suited for use in Von Mantel's formula, since the primary data necessary to calculate the PSY is the existing growing stock and the rotation period. The existing growing stock is available from the Crimp report and the rotation period has been established in Section 3.0 Assumptions.

Von Mantel's formula assumes that volume by age class increases in a linear progression as age class increases, and that there is a relatively even age distribution. This formula will tend to underestimate the yield from forests dominated by older ages. Accepting this premise eliminates the necessity for local-yield tables. Given that Von Mantel's assumptions are correct, the growing stock can be represented by the area within a right triangle formed by the rotation length as the base and the volume at rotation age as the height. Applying the standard formula for determining the area of a right triangle, the following formula for approximating annual PSY can be derived:

$$\text{Annual cut} = GS_{(actual)} / (RA/2)$$

Where:

$GS_{(actual)}$ = Total inventoried growing stock
RA = Rotation age

6.2 Tanana Valley Forest

By applying Von Mantel's formula to the data available for the Tanana State Forestry Lands, P&A calculated the following periodic yields for each vegetation type within each management unit. The results of these calculations are presented in Table 9.

Table 9
Volume Control by Management Unit

Vegetation Type	Total Type Volume (Table 12 mcf) (From Crimp Report)	Rotation Age (years)	Periodic Harvest Volume (10 years)
9a – Kantishna			
White Spruce	70,153	100	14,031
Poplar / Spruce	23,015	100	4,603
Hardwood / Spruce	224,295	100	44,859
Hardwood	209,159	70	59,760
Totals	526,622	--	123,252
9b – Fairbanks			
White Spruce	54,158	100	10,832
Poplar / Spruce	26,880	100	5,376
Hardwood / Spruce	338,396	100	67,679
Hardwood	189,406	70	54,116
Totals	608,841	--	138,003
9c – Delta			
White Spruce	70,148	100	14,030
Poplar / Spruce	13,675	100	2,735
Hardwood / Spruce	395,423	100	79,085
Hardwood	185,989	70	53,140
Totals	665,235	--	148,989
9d - Tok			
White Spruce	73,217	100	14,643
Poplar / Spruce	17,426	100	3,485
Hardwood / Spruce	190,895	100	38,179
Hardwood	22,371	70	6,392
Totals	303,909	--	62,699

Table10
Von Mantel Summary

Vegetation Type	Kantishna (mcf)	Fairbanks (mcf)	Delta (mcf)	Tok (mcf)	Total (10 years)
White Spruce	14,031	10,832	14,030	14,643	53,535
Poplar / Spruce	4,603	5,376	2,735	3,485	16,199
Hardwood / Spruce	44,859	67,679	79,085	38,179	229,802
Hardwood	59,760	54,116	53,140	6,392	173,407
Totals	123,252	138,003	148,989	62,699	472,943

Table 11
Comparison Area Control vs. Von Mantel

Management Area	Periodic Yield		Variation (%) Area / Volume
	Area Regulation (mcf)	Von Mantel (mcf)	
Kantishna	119,496	123,252	-3%
Fairbanks	134,252	138,003	-3%
Delta	122,843	148,989	-21%
Tok	44,492	62,699	-41%
Totals	421,084	472,943	-12%

Overall, the area control model provides a more conservative PSY estimate than the estimate calculated using the Von Mantel's control model.

7.0 Summary

The acres proposed for treatment under the area control model and the subsequent volumes derived from the average volume per acre per vegetation type provide a very conservative estimate of the volumes to be harvested in subsequent rotations of the Tanana State Forestry Lands. Selection of the area control model inherently provides a conservative estimate, since growth during the rotation period is not considered. Selection of the area control model assumes a static forest and is primarily useful for bringing unregulated forests under management.

Using the weighted-average volume per acre of the existing forest to convert the number of acres to receive silvicultural treatment to volumes introduces another conservative factor into the PSY estimate. The weighted-average volume per acre uses data that reflect the existing stocking level of the forest. Tree-per-acre data states that the Tanana Valley forest

is significantly under the 100-percent stocking levels. As the difference between a fully stocked forest and the stocking level of the forested land in the Tanana Valley decreases, so does the degree to which published data underestimates the PSY for the forest. The extent of this underestimation can become more pronounced during the second rotation period.

Based on the conservative nature of the data available for calculating the PSY of the managed forestlands in the Tanana Valley, the PSY values contained within this report will bring the forested lands under regulation within one rotation, providedthe harvest levels are realized. As new net growth data becomes available, the PSY value should be recalculated using a volume control model to verify the area control results.

Cited Materials

Crimp, Peter and Steve J. Phillips and Gordon T. Worum
1997. Timber Resources on State Forestry Lands in the Tanana Valley
State of Alaska, Department of Natural Resources
Division of Forestry

Davis, Kenneth P.
1966. Forest Management: Regulation and Valuation
Second edition, McGraw-Hill Book Company

Davis, Lawrence S. and K. Norman Johnson
1986. Forest Management
Third edition, McGraw-Hill, Inc.

Farr, Wilbur A.
1967. Growth and Yield of Well-Stocked White Spruce Lands in Alaska
Pacific Northwest Range and Experiment Station
Institute of Northern Forestry Juneau, Alaska
US Forest Service, USDA
Research Paper PNW-53

Forbes, R.D.
1955. Forestry Handbook
Society of American Foresters (SAF)
Ronald Press, inc.

Harlow, William M., and Ellwood S. Harrar
1969. Textbook of Dendrology
Fifth edition, McGraw-Hill Book Company

Husch, Bertram and Charles I Miller and Thomas W. Beers
1972. Forest Mensuration
Second Edition, The Ronald Press

Packee, Edward Ph.D.
Personal interview 1998 and 1999

Viereck, Leslie A., and Elbert L. Little
1972. Alaska Trees and Shrubs
U.S. Department of Agriculture, Forest Service
Agriculture Handbook No. 410

Wieczorek, Daniel H.
June 1980. Forest Resource & Allowable: Fairbanks Working Circle
Northcentral District Office, Division of Forest Land & Water Management, Alaska State Department of Natural Resources