Morice & Lakes IFPA

Morice & Lakes Innovative Forest Practices Agreement

OAF 1 Analysis

For The Bulkley, Morice, & Lakes TSAs

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Introduction

Under Section 7 of the Forest Act, when the Chief Forester of British Columbia determines the Annual Allowable Cut (AAC), consideration of the growth rates and yield for regenerated stands is one of the factors considered. Growth and yield models assist the Chief Forester in assessing yield in managed stands. TASS, the tree and stand simulation model is an individual tree, distance-dependent, crown-based model used by the Ministry of Forests to approximate yield in managed stands. TASS 'grows' trees in specific spatial stocking patterns. Information used to calibrate the model was derived from research plots measuring tree growth under ideal conditions with even spacing and without gaps. Because of perceived differences between this 'ideal' stand and actual stand conditions, provision for an operational adjustment factor was incorporated in TASS and its associated interpolation program, TIPSY (Tree Interpolation Program for Stand Yields).

There are two types of operational adjustment factors (OAFs) in TASS; OAF1, which addresses un-mappable stocking gaps and OAF 2, which is meant to address decay, waste and breakage and forest health concerns that are not static over the life of the stand. A type one OAF reduces volume to account for small stocking gaps, espacement patterns, and other factors that may cause parts of the stand to be unproductive relative to what TASS simulates. An OAF1 is intended to account for areas that are not already accounted for in other ways, such as the non-productive areas resulting from roads and landings, or areas with low stocking density. This summary addresses OAF1 stocking gaps due to natural areas such as swamps or rocky outcrops, non-commercial cover, slash piles, forest health losses, and windthrow that are not already accounted for in TASS.

The actual reduction necessary to approximate the yield of the average managed stand is not known and current defaults are conservative in order to account for unknowns that are difficult to quantify. On the recommendation of the BC Ministry of Forests (MoF) Research Branch, the default value for OAF1 is 15% for timber supply review purposes, where no local information exists to refine this figure. During Timber Supply Review Two, a default value of 15% was used in the Bulkley, Morice, and Lakes forest districts since no local factors were available to suggest otherwise (BC Ministry of Forests, 2001). One exception in the Lakes District was for stands with a pine component of at least 80% where the Regional Forest Pathologist recommended that an OAF1 value of 20% be used. It is generally recognized, however, that site-specific OAF1 values leading to more realistic default values are required to reflect actual stand characteristics with respect to stocking and tree distribution.

The current concept promoted in timber supply analysis (by timber supply branch), is that a type one OAF is comprised of four general types of net downs (Pers Comm., Nussbaum, 2001):

- OAF 1a: Non-productive areas e.g. rock outcrops, swamps.
- OAF 1b: Management effects – espacement and non-commercial cover
- OAF 1c: Losses due to forest health factors
- OAF 1d: Losses due to random risk factors.

These categories are somewhat arbitrary and serve as a starting point for assessing OAF1. In general, timber supply branch expects that a net down due to stocking gaps of roughly 4% for each of the above factors will be used unless data can be provided to indicate otherwise.

When assessing a stand, however, the area currently unoccupied by trees cannot be assumed to be a stocking gap. There are two reasons for this. Firstly, tree crowns on the edge of a stocking gap grow into it, reducing the effect of the gap. Secondly, TASS already simulates the effects of stand density and incorporates some gaps at lower stocking levels.

In order to appropriately identify stocking gaps during a silviculture survey, therefore, the area unoccupied by trees must be reduced by some amount to reflect crown extension into the gap and how TASS models this. One way of doing this, is for the surveyor to assume that they are in a gap only when they are far enough away from any tree, such that the gap created, results in a yield reduction when modeled in TASS. The distance at which yield starts to be effected was termed the critical distance (CD) (Laing & McCulloch 1997). Critical distance (CD) is an expression of the relationship between stocking holes in a stand and their impact on merchantable yield. Different critical distances are used for different species as indicated in table 1.

Table 1. Critical distance values.

Species	Distance (m)
Lodgepole Pine (Pl)	2.7
White Spruce (Sw)	2.7
Interior Douglas-fir (Fdi)	3.6
Coastal Douglas-fir (Fdc)	3.6
Western Hemlock (Hw)	3.6
Sitka Spruce (Ss)	3.6
Western Red Cedar (Cw)	3.6

Objectives

As a means of increasing the accuracy of predicted sustainable harvest levels from the productive land base, a main objective of this project was to collect sufficient data to obtain localized OAF1 estimates. This project is a continuation of an IFPA OAF1 initiative from 2001 in which substantial data were collected in the Bulkley, Morice, and Lakes TSAs for site series that were not previously sufficiently sampled. The primary goal of this project was to augment data already obtained including the testing of the sensitivity of the ground based survey method to critical distance, and determine areas where there is potential for current OAF1 defaults to be changed. It is anticipated that any recommendation resulting from this data must satisfy the chief forester that a change from the provincially accepted default value of 15% is appropriate.

The development of stocking gap information across the three TSAs for derivation of accurate ground based OAF 1 values is important in modeling timber supply and it is expected that it will be used in future TASS analyses. The intention is to develop OAF1 values by site series as it is expected that site series will be closely correlated with stocking distribution. Based on results from both years, it is expected that OAF1 values significantly lower than the default value of 15% will be obtained.

The proposed application of this data includes timber supply analysis, scenario planning as required in the McGregor initiative for the SFM plan and, possibly, in level two silviculture analyses.

Methods

Laing & McCulloch Forest Management Services Ltd conducted the OAF1 field sampling in the Lakes, Morice, and Bulkley forest districts during the 2002 field season. The objective was to collect a maximum of fifty OAF 1 samples per biogeoclimatic site series representing at least 2% of the THLB in any given district, based on the hypothesis that OAF1 may by related to site series.

Data was collected at each OAF 1 sample point consistent with the *Ground Based Survey Methodology Report 2* (Martin, 1998) except for modifications indicated below (download the report from www.for.gov.bc.ca/hfp/pubs/htm). Since the objective was not to determine OAF value for each block surveyed, but rather, to determine OAF value by site series, sample intensity differed from that suggested by Martin. The procedure that was used for data collection is described below.

- Measure the distance from the plot centre to the nearest **acceptable** tree if less than 3.99m away (instead of using the 2.7m rule). An acceptable

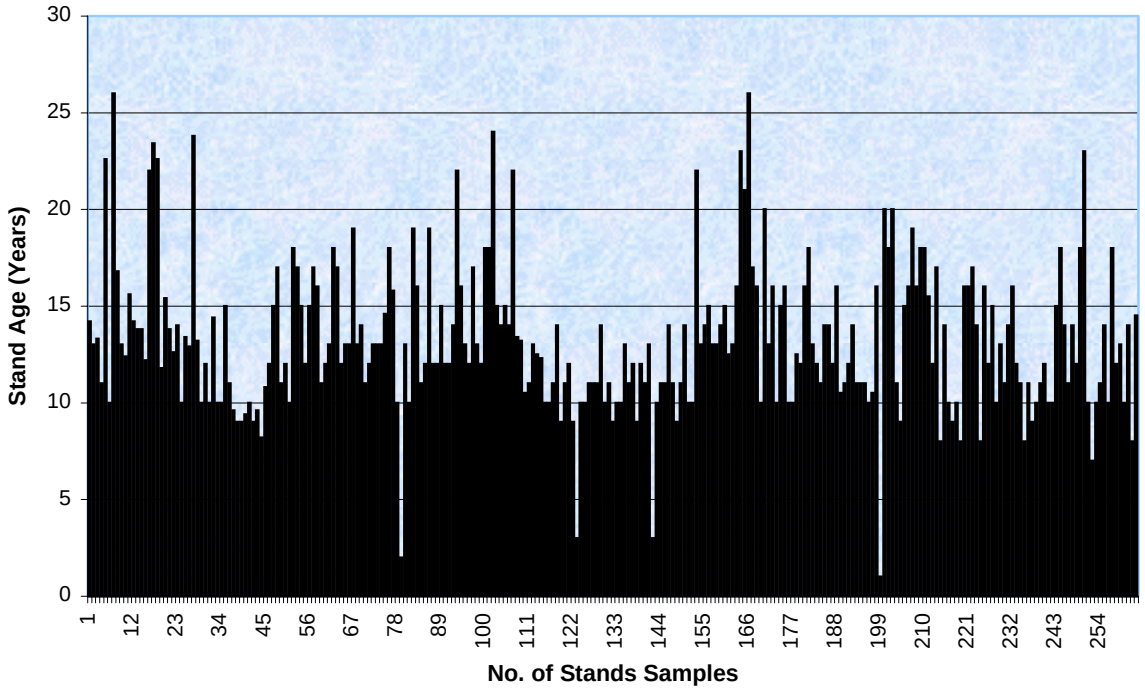
tree is one that is ecologically suited to the site per the establishment to free growing guidebook, >20% of the height of the average crop tree, and which exceeds the damage thresholds in the free growing damage criteria for the Prince Rupert Forest Region. Note that the surveyor must not bias the location of the plot centre. That is, the surveyor will establish plots at a fixed distance that does not vary within the stratum.

- Record the species of acceptable tree nearest to the plot centre.
- Record the species composition in the plot.
- If the plot is empty, record why it is empty.
- If there are **no** acceptable trees in the plot less than **2.7 m away**, but there are trees that would have been acceptable if it weren't for some forest health factor (e.g. stem rust), record which forest health factor is causing the plot to be empty.
- Record the site series at the acceptable tree closest to the plot centre.
- Record total trees/ha for the plot.
- Estimate and record average stand age in the plot.
- Record whether the stand was planted or established naturally.

Target Sample Population

- Sampling was limited to certain site series within stands that were currently between 10 and 40 years of years of age and which were located in geographic areas not adequately represented by previous sampling. A pre-survey decision was made on-site as to whether ingress was complete in these stands to ensure that the survey results would provide an accurate OAF 1 value.
- Figure 1 depicts the age distribution of the sample stands contained in the study area. Two hundred and sixty four stands were sampled and the average stand age was 13.2 years.

Figure 1. Age Distribution of Sampled Stands



- A list of suitable polygons that met the above stand requirements for OAF 1 sampling was extracted for the Bulkley, Morice and Lakes Districts using available PEM mapping and a derived ecosystem coverage produced by the McGregor Model Forest Association called DEC. Existing databases such as ISIS and MLSIS were also considered, however, they generally lacked the level of detail (i.e. specific site series location) required to develop a random systematic sampling plan.

- Prior to contract commencement, the project team explored the suitability of various types of free growing surveys (pre- 2001) and silviculture prescriptions (pre-1995).

- Geographic areas that had been previously sampled were only considered for additional sampling if no other suitable areas were available.

Sample Selection

Sample size and distribution corresponded to the following general rules:

- The target number of OAF1 plots in each site series was 50 (combined total for both years). Time and budget constraints precluded the establishment of additional samples. The OAF1 Project Report #2

recommends 100 plots within an area, however, confidence in the statistical reliability ($p<0.05$) of the 2001 data was observed for site series with as few as 10 samples. A large standard error generally only occurred where less than 5 plots were collected and there were empty plots. The requirement to collect 100 plots was not based on any statistical analysis of expected variance but was to be regarded as a maximum. Since the objective is not to determine OAF value for each block surveyed, but rather, to determine OAF value by site series, sample intensity differed from that suggested by the OAF1 Project Report #2.

- Site series were not sampled where it was known that they represented less than 2% of the timber harvesting landbase in any of the districts being sampled (see Bulkley Timber Supply Area OAF 1 Analysis, FRBC project #720711). For site series representing less than 2% of the landbase, it was felt that it would not be possible to obtain a large enough sample of harvested blocks that met the minimum age criteria of 10 years. Concentrating on site series representing at least 2% of the landbase helped improve sampling efficiencies by enabling the greatest proportion of the landbase to be sampled with limited funding.

- The Morice PEM was used to determine which site series represent more than 2% of the landbase in the Morice TSA, while the McGregor DEC was used to determine which site series represent greater than 2% of the Lakes TSA landbase. Data from the Bulkley Timber Supply Area Analysis report (2001) was used to identify site series that made up at least 2% of the Bulkley timber harvesting landbase. Forest cover maps showing BEC subzones and harvested blocks meeting the age criteria were then used to refine potential sampling areas. Previous free growing survey and silviculture prescription results, as well as local knowledge, were then used to help identify specific sampling locations.

- In all districts, confirmation of the subzone/site series was made on site and sampling proceeded only when if was deemed by professional judgment that the site series in question represented at least 60% of the stratum to be sampled. Although they represented greater than 2% of the Bulkley THLB, no samples were located in the CWHws2 and the MHmm2 because logging history in these areas is relatively recent and there were insufficient candidate stands.

- No more than 10 plots were to be established in any quadrant of either TSA (to obtain better geographic distribution and to avoid sampling on mapsheets that were adequately sampled in 2001). It was recognized early on, however, that some site series may be concentrated in specific geographic areas within a TSA, or have limited access, and that it would likely be necessary under these circumstances to establish more than 10 plots per quadrant in order to meet the 50 plot sampling target.

- Despite bullets one and two above, plots were only collected for the SBSdk 01, SBSdk 05, SBSmc2 01, SBSmc2 05, and SBSmc2 06 site series if they were located in specified quadrants of any of the districts.

- Despite bullet one above, the target maximum number for the SBSdk/01, SBSdk/05, SBSmc2/01, SBSmc2/05, and SBSmc2/06 was only 25 plots because these sites were adequately sampled in 2001 and additional plots were for geographic distribution only.

- No more than 5 plots were established in any site series in one cutblock. Sample site distribution is illustrated on a large-scale map found in Appendix I. The map depicts the areas where samples were collected over the three districts. Only on three occasions, when it became apparent that there would be insufficient sampling locations to obtain the target number of samples was this rule deviated from. In all cases, however, no more than eight plots were established for a specific site series on any given cutblock.

- Sampling was focused on areas that had a high concentration of cutblocks with representative site series, in order to improve sampling efficiencies and render the contract more cost effective.

- Map identifiable points of commencement (POC) were located and plots selected in a systematic, unbiased manner, once the site series was confirmed and the size and shape of the stratum to be sampled was established.

Data Compilation and Analysis

The 2002 field sampling results were summarised and combined with last year's results for analysis by Laing & McCulloch and are presented in Appendix 1 – '2001/2002 OAF1 Field Sampling Data'. The summary includes OAF1 values for all data combined and by Biogeoclimatic zone (BEC). Additional breakdowns were planned (e.g. by District by species,) however, as a result of the repeated achievement of 0% for OAF1 values further analysis was not deemed to be useful. The following analysis was undertaken:

- An excel spreadsheet listing all data collected.

- A record, in separate columns, whether the plot would be empty or not if the critical distance were 2.0 to 4.0 m in increments of 0.1m (e.g. 2.0, 2.1, 2.2 …. 3.8, 3.9, 4.0).

- Using data sets from the previous year and the current year, derivation of the OAF1 value was undertaken by determining the lower confidence

limit for the random binomial variable percent empty plots (PEP) for each stratum (supplied by the contract administrator) by entering the data in the OAF1 calculator found at:
http://www.for.gov.bc.ca/pScripts/hfp/oaf1/Calc.asp

Results and Discussion

A total of 1264 point samples were obtained across the three TSAs between 2001 and 2002 (586 in 2001 and 678 in 2002). Preliminary analysis suggests that a default value of 15% is not appropriate for many sites in the Bulkley, Lakes and Morice TSAs. Field confirmed OAF1 values are much lower (0% in most cases). The summary for each site series is outlined in the table below.

Table 2: 2001/2002 Results Table

*Calculations done using the OAF1 calculator found at: http://www.for.gov.bc.ca/pScripts/hfp/oaf1/Calc.asp

ANALYSIS UNIT	# OF PLOTS	PEP%	CRITICAL DISTANCE	TOTAL TREES/HA	PLANTED/ NATURAL	SITE INDEX[1]	LEADING SPECIES	OAF 1 VALUE TIPSY ver. 1.3
SBSdk 01	126	2.4	2.7	2895	P	20.0	Pl	0
SBSdk 05	52	3.8	2.7	2873	P	20.0	Pl	0.2
SBSdk 06	55	5.8	2.7	2815	P	20.0	Pl	1.8
SBSdk 07	55	16.4	2.7	1920	P	20.3	Pl/Sx	11.0
SBSmc2 01	316	0.9	2.7	2772	P	20.7	Pl/Sx	0
SBSmc2 01c	40	2.5	2.7	2700	P	20.0	Pl	0
SBSmc2 05/06	176	1.2	2.7	2259	P	20.8	Pl/Sx	0
SBSmc2 09	50	10.0	2.7	1826	P	21.6	Sx (Pl)	5.2
SBSmc2 10	50	4.0	2.7	1408	P	15.2	Sx	0.4
ESSFmc 01	50	2.0	2.7	3136	P	11.5	Pl (Sx)	0
ESSFmc 04	50	0	2.7	2946	P	11.0	Pl (Bl)	0
ESSFmc 05/06	50	4.0	2.7	2160	P	13.4	Sx (Pl/Bl)	0.4
ESSFmc 09/10	56	16.1	2.7	1481	P	10.6	Sx (Bl)	10.0
ESSFwv 01	50	4.0	2.7	2224	P	12.4	Sx (Pl)	0.4
ICHmc1 01	57	0	2.7	2526	P	18.8	Pl (Sx/Hw)	0
ICHmc1 03	50	4.0	2.7	1976	P	20.7	Sx/Pl	0.4

[1] Site index was determined using the growth intercept method where suitable stands existed and through site series correlation where they did not.

Note that OAF1 calculations are currently not available for balsam or deciduous species. In addition, the OAF1 values computed from the ground-based survey method are appropriate for TIPSY ver. 1.3 and may not be

appropriate for subsequent versions of TIPSY if the underlying yield tables are changed, or for other yield models (Martin, 1998).

A standard deviation for the random binomial variable *percent empty plots* (PEP) was calculated for each of the site series described above using the formula SD = SQRT {(#empty plots/total plots x total plots) x [1 – (# empty plots/total plots)]}[1]. Standard deviation for the PEP values was used to determine corresponding OAF values using the MoF calculator (http://www.for.gov.bc.ca/hfp/OAF1/intro_calc.htm). Results of this analysis are shown in Table 3.

Table 3. Standard deviation for OAF values by site series.

Site Series	PEP	OAF1
SBSdk/01	0.7 – 4.1	0.0 – 0.5
SBSdk/05	2.4 – 5.2	0.0 – 1.4
SBSdk 06	4.7 – 6.9	1.0 – 2.7
SBSdk 07	13.7 – 19.1	8.6 – 13.4
SBSmc2/01	0.0 – 2.6	0.0 – 0.0
SBSmc2 01c	1.5 – 3.5	0.0 – 0.0
SBSmc2 05/06	0.2 – 2.2	0.0 – 0.0
SBSmc2 09	7.9 – 12.1	3.5 – 6.8
SBSmc2 10	2.6 – 5.4	0.0 – 1.5
ESSFmc 01	1.0 - 3.0	0.0 – 0.0
ESSFmc 04	0.0	0.0 – 0.0
ESSFmc 05/06	2.6 - 5.4	0.0 – 1.5
ESSFmc 09/10	13.3 – 18.9	7.6 – 11.6
ESSFwv 01	2.6 – 5.4	0.0 – 1.5
ICHmc1 01	0.0	0.0 – 0.0
ICHmc1 03	2.6 – 5.4	0.0 – 1.5

OAF1 values for these site series averaged less than 2% on a weighted average basis. Overall, 51 of the 1264 plots (4.0%) had spacing gaps greater than 2.7m critical distance. Only 18 of the 1264 plots (1.4%) had spacing gaps between 3.6m and 4.0m critical distance.

Further analysis demonstrates that OAF1 estimates are sensitive to critical distance. Table 4 summarizes the standard deviation for OAF1 values of selected site series (SBSmc2/01, SBSdk/05,07, and ESSFmc 09/10) by critical distance. When critical distances were decreased from 2.7 to 2.3m, OAF1 values increased by 1.0% to 9% and when critical distances were increased from 2.7m to 3.0m, OAF1 values decreased by up to 2.4%.

[1] Jay Devore and P. Roxy, Introductory Statistics, 2nd Ed, West Publishing Co., 1994

Table 4. Standard deviation for OAF1 values by site series and critical distance.

Site Series	CD	PEP	OAF1
SBSmc2/01	2.0	1.6 – 9.8	0.0 – 5.3
	2.3	0.0 – 4.3	0.0 – 0.6
	2.7	**0.0 – 2.6**	**0.0 – 0.0**
	3.0	0.0 – 2.6	0.0 – 0.0
	3.3	0.0 – 0.0	0.0 – 0.0
SBSdk/05	2.0	5.8 – 9.6	1.8 – 5.1
	2.3	2.4 – 5.2	0.0 – 1.4
	2.7	**2.4 – 5.2**	**0.0 – 1.4**
	3.0	2.4 – 5.2	0.0 – 1.4
	3.3	0.9 – 2.9	0.0 – 0.0
ESSFmc/09/10	2.0	35.7 – 42.9	Error (PEP too high)
	2.3	21.8 – 28.2	15.5 – 20.6
	2.7	**13.3 – 18.9**	**7.6 – 11.6**
	3.0	10.0 – 15.0	5.2 – 9.2
	3.3	10.0 – 15.0	5.2 – 9.2
SBSdk/07	2.0	32.8 – 40.0	Error (PEP too high)
	2.3	18.7 – 24.9	13.4 – 19.2
	2.7	**13.7 – 19.1**	**8.6 – 13.4**
	3.0	11.9 – 17.1	7.5 – 11.8
	3.3	10.2 – 15.2	5.5 – 10.2

Conclusion

In summary, conclusions that can be drawn from the 2001 - 2002 OAF1 analysis are:

- The SBSdk 01/05/06,SBSmc2 01/01c/05/06/09/10,ESSFmc 01/04/05/06, ESSFwv01,and ICHmc1 01/03 site series have been sufficiently sampled to form a conclusion for an appropriate OAF 1 value.

- Definitive conclusions can be reached for these areas as the site series in which sufficient data were collected represents a significant portion of the Bulkley, Morice, and Lakes TSAs and the geographic distribution of plots across these areas was reasonably wide.

- It is clear from the results obtained from the 2001 and 2002 OAF1 sampling projects that OAF1 values in planted stands are very unlikely to be as high as 15% currently used as default.

- Licensees in the Bulkley, Lakes, and Morice TSAs should consider the value of OAF1 surveys in identifying opportunities for enhancing stocking to achieve optimum levels. This is particularly true for the ESSFmc 09/10 and SBSdk 07.

Recommendations

It is recommended that an OAF1 value of 5% be considered for the following site series:

- SBSdk 01/05/06,
- SBSmc2 01/01c/05/06/09/10,
- ESSFmc 01/04/05/06,
- ESSFwv 01

For sites regenerated with pine in the ICHmc1 01/03 site series, it is recommended that the current 15% default value be utilised until further notice. As a result of the current Dothistroma needle blight outbreak in northwest BC, there is concern regarding the potential effects of Dothistroma on pine stands in the ICH. Although evidence of this forest health damaging agent was minimal within the study area, as a cautionary measure, it may be prudent to continue using the default value of 15% for pine stands in the ICH zones of the Bulkley TSA until more is known on the impacts of Dothistroma.

A value of 5% is recommended for the sites listed above based on the 2001 and 2002 field sampling programs and direction from timber supply branch. OAF values for site series representing less than 2% of the land base should be defaulted to the value used for the site series adjacent to it on the edatopic grid, to the extent that they fall into the same broad category of ecological condition (dry poor, mesic mesotrophic, and wet rich).

This figure (5%) is based on the combined results from the 2001-2002 OAF1 data in which an OAF1 value of 0–1.5% was repeatedly achieved on the aforementioned sites. It also incorporates direction from Albert Nussbaum that future risk must be considered. The preliminary OAF 1 estimate of 5% also represents the professional opinion of the author based on knowledge of local conditions and past experience in determining OAF 1 values. For example, in the Bulkley TSA, in stands older than 15 years there is little likelihood of pests that will kill more stems than already accounted for at free growing, therefore the percent netdown attributed to future forest health losses can be reduced, resulting in an OAF 1 estimate of 5%.

For the SBSdk 07 and ESSFmc 09/10 site series, an OAF1 value of 10-15% is considered appropriate. It is noteworthy that the OAF1 values of 10-11% obtained for theses sites were a result of issues with tree quality than with actual stocking gaps even though these sites are often at the extreme ends of the ecological spectrum, where stocking and tree distribution are more likely to be erratic.

It is anticipated that the recommended OAF values for the Bulkley, Lakes, and Morice TSAs will satisfy the Chief Forester's requirements for utilizing OAF values that deviate from the provincial defaults for future Bulkley TSA timber supply reviews.

References

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Appendix I

Plot Distribution Map