An assessment of koala survey data from an Adaptive Management perspective

Introduction

Action 4.7 of the NSW Koala Recovery Plan was to "Undertake studies of the history of koala management as part of an adaptive management strategy". The data from recent koala surveys should provide the opportunity to consider forest structure and species distribution, as part of an adaptive approach to koala habitat management.

While there are few details on forest management prior to the introduction of integrated logging for sawlogs and pulp-logs in the Eden region, previous research [1] has documented details of forest management activities in Mumbulla State Forest, where as a result of a koala sighting in 1997, the koala surveys were initiated.

Although there is uncertainty about former Crown Land areas to the north along the Murrah River, all of the accessible areas in Mumbulla SF have been logged at least once and some up to four times prior to the introduction of integrated logging. The most intensive of these and the pre-cursor to integrated logging, is thought to be 'Timber Stand Improvement'.

Undertaken in the early 1960's these operations aimed to remove all the large trees, termed 'over-wood', because of perceptions that their presence was retarding the growth of the 'future crop' of 'high quality sawlogs'.

To date none of the Timber Stand Improvement areas have been subject to integrated logging and Forests NSW current Plan of Operations is the first to propose logging of the TSI areas. A gross area of 3,203 ha. or 52% of the present Mumbulla State Forest has been subjected to integrated logging.

Data

> " . . . The radius of each of the sites was only recorded in the later half of the survey. Of those sampled (n=202), the variation was not substantial (range 8-40m, mean = 20.1 ± 0.4 m), with 70% of these sites having radii between 15-25m." [2]

The information from the koala surveys came in the form of two Excel spreadsheets. One providing location and other details of 621 non-sequentially numbered plots, 203 of which had had the radius of the plot recorded. Of the 203 plots where the radius was recorded one had an incorrect easting and another two had details of 2 trees missing. Initial analysis found the plot with the smallest radius (8m) had incorporated

---

1 Lunney, D. and Moon, C. (1988) AN ECOLOGICAL VIEW OF THE HISTORY OF LOGGING AND FIRE IN MUMBULLA STATE FOREST ON THE SOUTH COAST OF NEW SOUTH WALES. National Parks and Wildlife Service (N.S.W.) Sydney, New South Wales. http://www.foresthistory.org.au/publications.html

2 Welsh, A., Cunningham, R., and Donnelly, C., (May 2010) A statistical analysis of relationships between Koala occupancy and tree habitat in the Bermagui / Murrah area, NSW. ANU http://www.fiveforests.net/resources/Cunningham100525.pdf

a road, suggesting an incorrect radius measurement and this plot was also excluded. Koala activity was recorded in 25 of the remaining 199 plots with a radius.

The other Excel spreadsheet provided details on 17,770 trees including species, Diameter at Breast Height (DBH) and the number of stems per tree.

Methods

Point locations of Koala survey plots with a radius were intersected with integrated logging history and a pre-woodchip-logging history (adapted from Lunney and Moon, 1988). The subsequent DBF file was imported into a database, queried against the spreadsheet providing tree details for the plots and the new file was exported to Excel for analysis.

The Tree Diameters at Breast Height (DBH) were converted to Basal Area (BA) and employing the plot radius converted to three BA per hectare figures.

1. BA per hectare of the total DBH
2. BA per hectare produced by dividing the DBH by the number of stems prior to converting to BA
3. The latter figure but with non-commercial species removed namely A. floribunda, the smaller tree species like A. littoralis, Acacias and rainforest species.

Uncertainties about aspects of the plot data led to a more detailed analysis of the 10 plots with the highest and lowest BA and a ‘re-measure’ of three plots in Mumbulla State Forest, one in the TSI area, another in an area subject to integrated logging and the third in an area indicated as being subject to ‘ Crown logging’ (ibid).

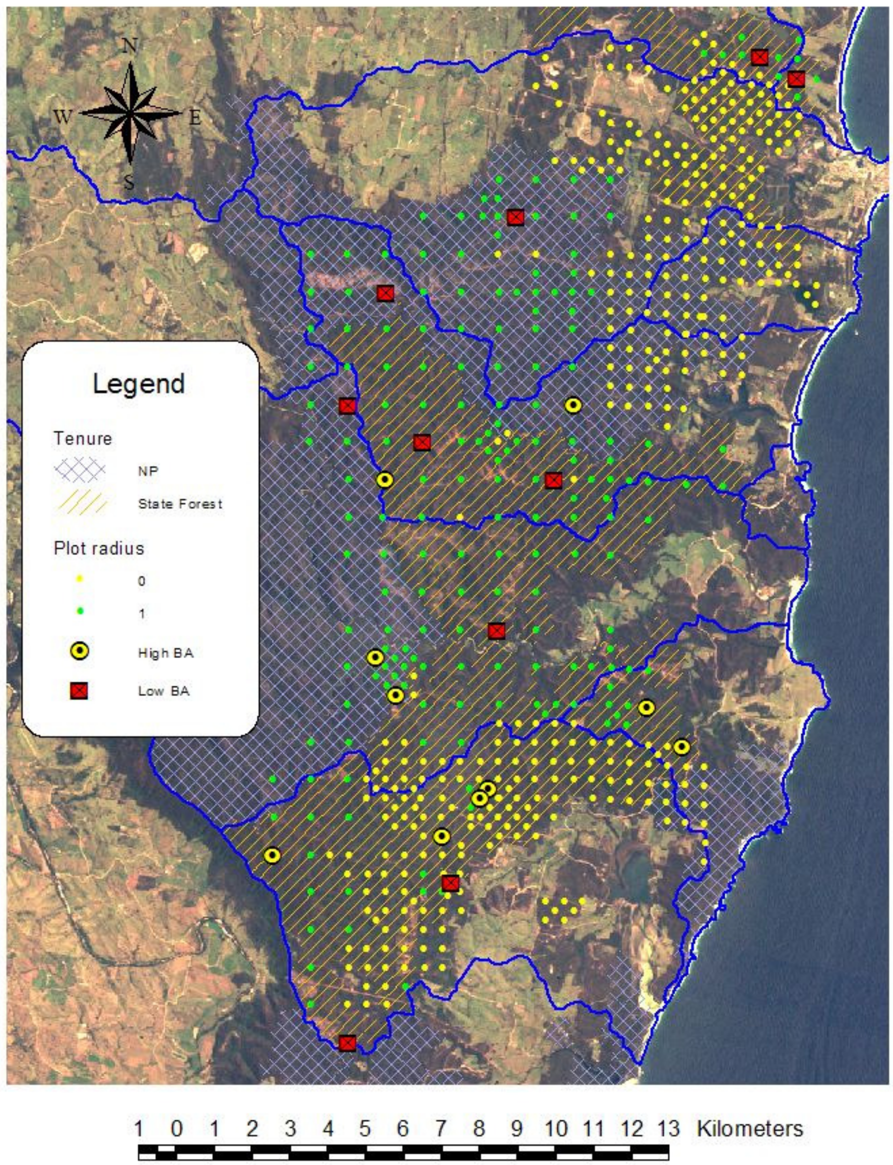
Results

The following table provides the highest, average and lowest Basal Areas of the 199 plots. Neither of the plots with highest and lowest BA/HA has been subjected to integrated logging.

BA/HA	Plot Radius	BA(m^2)/HA	BA(m^2)/HA-stems	BA(m^2)/HA HQ stems
Highest	10	106.9	106.9	88.7
Average	20.5	33.8	31.5	27.5
Lowest	40	4.5	4.5	3.6

The locations of plots with and without a radius, the 10 plots with the highest and 10 plots with the lowest Basal Areas are illustrated in the following graphic.

Distribution of plots with/without radius and high and low basal area plots



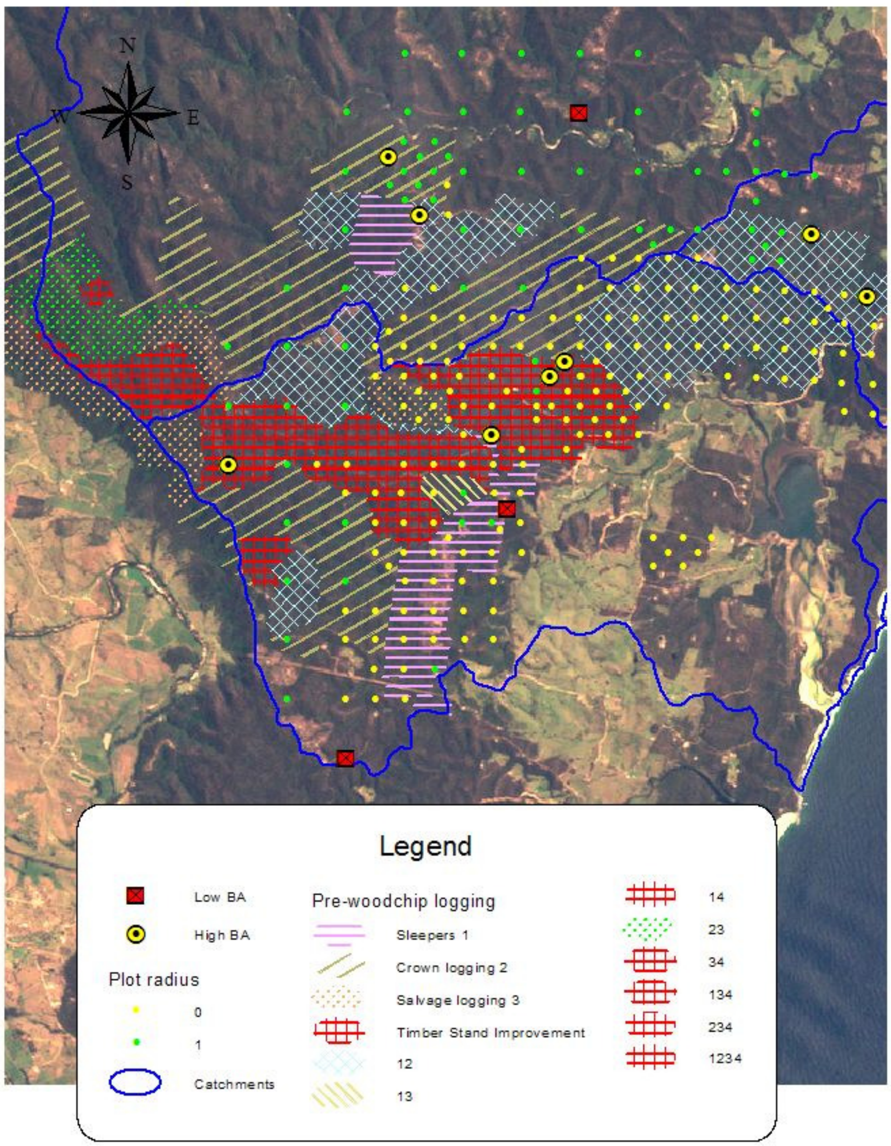
Of the plots with low BAs, six are located on State Forest, three in National Park and one on private land. Two of the low BA plots on State Forest are located in Compartment 2001, currently (August 2011) being logged and according to the Harvesting Plan has a BA across the compartment of 25m².

Another is located in Coupe 2 of Compartment 2051 that was subject to integrated logging in 1986 and is currently scheduled for 'thinning". According to the

Harvesting Plan the BA in this coupe is 26m² although the plot data suggests 9.4 to 12.1m².

Of the plots with the high BAs, seven are in State Forest and three in National Park. One of these is in Coupe1 of Compartment 2051 and has a BA range of 60 - 67.3m², although the Harvesting Plan doesn't contain a BA figure.

Distribution of plots and pre-woodchip logging history (adapted from Lunney and Moon)



As indicated in the graphic above one of the low BA plots is in an unlogged coupe on the southern edge of Mumbulla SF and the other is on private land. Two of the high BA plots are in National Park, while six are in Mumbulla SF with four of these in TSI areas.

Remeasured Plots

The following table is based on the data (Appendix 1), from three plots provided under the GIPA Act and a remeasure of the plots. The TSI plot did not have a radius recorded so the 14 metre radius determined on the remeasure has been employed.

Logging History	Data source	Total DBH	Total BA/HA	BA/HA stems	BA/HA HQ single stem commercial species
Crown Logging	OE&H data	14168	21.9	0	21.4
	Remeasure	13852	21.2	0	20.6
Integrated Logging	OE&H data	8527	40.5	0	28.9
	Remeasure	8148	32.4	0	21.6
Timber Stand Improvement	OE&H data	10569	56.1	18.6	9.7
	Remeasure	8967	42.6	19	12.9

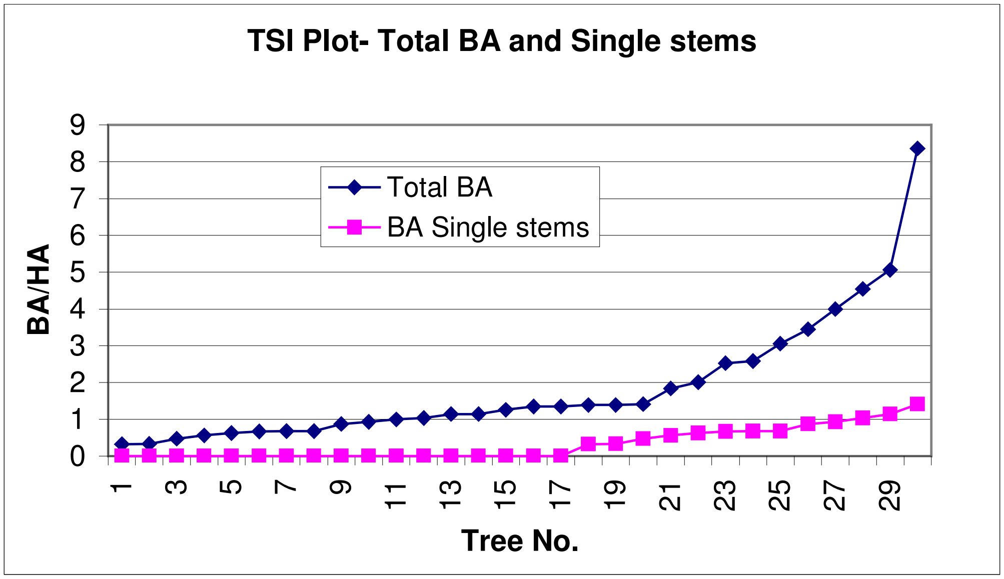
As indicated in the table the remeasure found DBH's to be 5-15% lower than the OE&H data. The trees that occur in the OE&H data but were not located during the remeasure partly explain this discrepancy.

The 'Crown logging' plot is located on a ridge line with a northerly aspect in area of "Old Growth" (13.5 ha.) that is part of 42.9 hectares of 'Old Growth' in Mumbulla SF, notionally protected from logging. This plot, all things being equal, should provide a baseline for forest structure in previously (>40 years ago) selectively logged forest. An additional Woollybutt (*E. longifolia*) is recorded in the OE&H data that was not located during the remeasure. The radius recorded in the OE&H data (30 metres) was consistent with the remeasure and there were no trees with more than one stem in the plot.

The 'Integrated logging' plot was logged in 1980, is located in an upper slope position, also with a northerly aspect and incorporates a dry watercourse on the western side. The death of two Forest Oaks (*A.littoralis*) in the plot area resulted in an increase in the plot radius from 15 to 16 metres. This increase incorporated two more Forest Oaks of a similar DBH making 22 of the 30 trees Forest Oak and there were no trees with more than one stem in the plot. Two additional Woollybutts (*E. longifolia*) recorded in the OE&H data were not located during the remeasure although there was one other Woollybutt with a DBH below 150mm in the plot area.

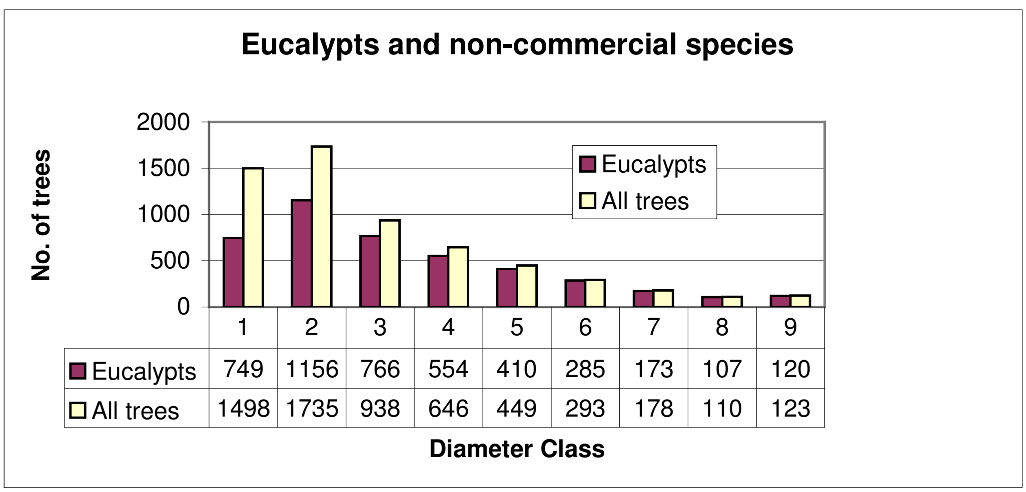
The 'Timber Stand Improvement' plot is located on a lower slope, just above a drainage depression and also has a northerly aspect. While it is possible that tree growth had led to some trees in the plot area now exceeding 150mm BDH, the OE&H data provides for two Silvertop Ash (*E. sieberi)* that were not located during the remeasure.

The following chart compares the total BA/HA as derived from the OE&H data with the same data but downgrades multi-stemmed trees, generally coppice growth from the lignotuber, because they are unlikely to produce a high quality sawlog. There were 17 trees or 57% of those in the OE&H data where multiple stems recorded. Nine trees or 30% of those remeasured had multiple stems.



As indicated above trees with single stems accounted for a BA/HA of 9.7m² that, after nearly fifty years of growth, suggests that this location, like many others[3], is unlikely to provide a future ‘high quality sawlog’ crop.

The following chart shows the number of eucalyptus species per diameter classes, compared with the number of all trees in the 199 plots.



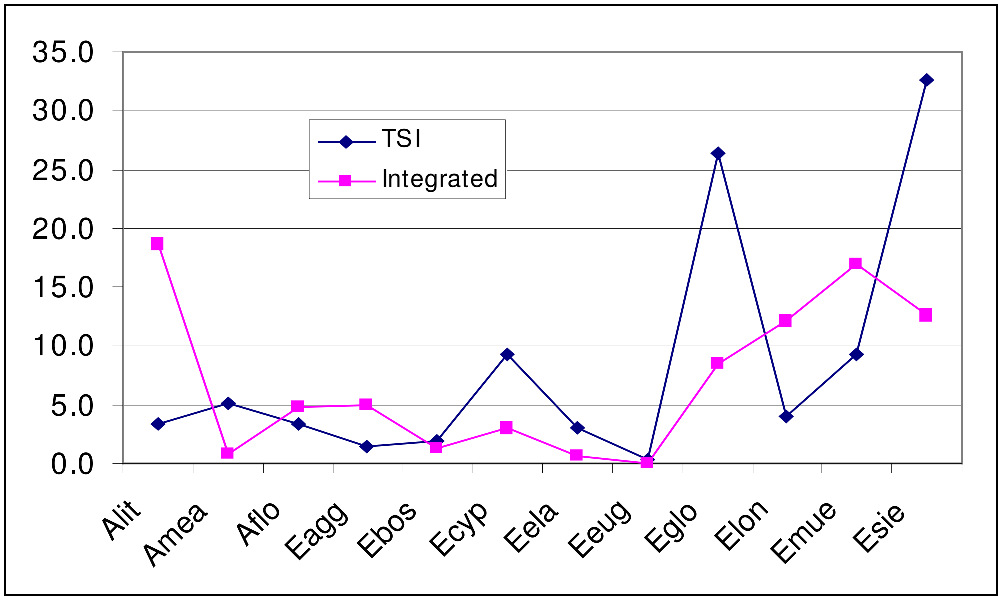
	1	2	3	4	5	6	7	8	9
Eucalypts	749	1156	766	554	410	285	173	107	120
All trees	1498	1735	938	646	449	293	178	110	123

---

[3] Nambiar, S., (2010) Sustainability of eucalypt plantations in Australia is failing. Guest Editorial- Australian Forestry, Institute of Foresters of Australia
http://www.thefreelibrary.com/Australian+Forestry/2010/December/1-p52104

Diameter Class 9 incorporates all trees greater than 900mm DBH. Species that are not eucalyptus account for half of the trees in the 150-199mm diameter class (1) and one third of trees in the 200-299mm diameter class (2).

The following chart compares the diversity of tree species, represented as a percentage, of Timber Stand Improvement plots (n=8) with the percentage of the same species from plots (n=85), previously subjected to integrated logging.



Despite the small sample in the TSI area the inference is that an outcome of these operations is stands dominated by White stringy-bark (*E.globodia*) and Silvertop Ash (*E.seberi*). Just over one fifth (21.2%) of the trees in the TSI plots had multiple stems.

The trend in areas subjected to integrated logging is for Forest Oak to dominate the stand followed by Yellow Stringybark (*E. mulleriana*) and Silvertop Ash. Woollybutt (*E.longifolia*) (n=484) accounted for 10.2% of trees in measured plots while Silvertop Ash (n=760) represented 12.7%. However, Woolybutt is not suitable for pulp and accounted for 15.5% of trees (n=233) 800mm DBH or greater while Silvertop Ash accounted for only 11.2% of these trees.

In the smallest diameter class, trees up to 199mm DBH (n=3233), Woollybutt accounted for 4.9% whereas Silvertop Ash occurred at more than double that number at 11.6%

Comment

At the completion of the pilot study[4] the opportunity presented itself to maximise the utility of the survey methodology. Instead, changes to the methodology, beginning with the increase to a 1 kilo-meter grid and then reverting back to the original methods upon locating koala evidence were counter productive. Had measuring the plot radius been the first change to the methods it would have provided Forests NSW with at least some forest inventory data as required under Eden Regional Forest Agreement (Clause 46.f).

While the NSW Government agencies have traditionally displayed a lack of interest in accurate details on the forests they manage, there is also the uncertainty about whether the methodology for measuring DBH's was consistently adhered to and the inclusion of trees not located during plot remeasures cannot be explained. These issues are of particular concern given the original analysis[5] was apparently based on the total DBH of the plot and there is the additional uncertainty of whether the number of stems per tree was accounted for.

The original analysis of the data attempted to prioritise tree species assumedly so that logging prescriptions could be devised. However, those species found to be 'poorly related to the presence of koalas' namely Red Bloodwood *(Corymbia gummifera),* Spotted gum *(Corymbia maculata)* and Bangalay*, (E. botryoides)* and those tree species where koala faecal pellets were most commonly and less frequently found, are represented in the various combinations of trees that make up 'Coastal Foothills Dry Shrub Forest'[6].

The data does appear to confirm that changes to tree species diversity is leading to ecosystem simplification that, like extensive canopy dieback and declining koala numbers, is associated with soil degradation. All of the remeasured plots had trees with evidence of dieback.

Such outcomes are not beneficial for koalas and are arguably inconsistent with the concept of Ecologically Sustainable Forest Management, the Objects of the NSW Forestry Act (1916), the NSW National Parks and Wildlife Act (1974), the National Forest Policy Statement (1992), the Eden Regional Forest Agreement (1999) and the Australian Forestry Standard.

Robert Bertram
15 August 2011

---

[4] Biolink Ecological Consultants (2007) The utility of regularised grid-based sampling for the purposes of identifying areas being utilized by koalas (*Phascolarctos cinereus*) in the South-east Forests of NSW – a Pilot Study. Report to NSW Dept. Environment & Climate Change
http://www.fiveforests.net/resources/Wapengo%20report.pdf

[5] McDougall, K., Allen, C., Saxon, M., (February, 2010) Koala surveys in the coastal forests of the Bermagui-Mumbulla area: 2007-2009, An interim report. Department of Environment and Climate Change and Water, 59 Goulburn Street, Sydney PO Box A290, Sydney South 1232.
http://www.environment.nsw.gov.au/resources/threatenedspecies/10116koalabermmum.pdf

[6] Keith, D., Bedward, M. (1999) Native Vegetation of the South East Forests region, Eden, New South Wales: Cunninghamia, Volume 6(1) 1999, National Herbarium of New South Wales, Royal Botanic Gardens, Mrs Macquarie Road, Sydney, NSW 2000.

Appendix 1

Plot	Species 1	DBH 1	Stem 1	Plot Radius1	Species2	DBH2	Stem 2	Plot radius2
TSI	Ebot	285	1	0	Ebot	252	1	14
TSI	Ebot	560	2	0	Eglo	670	3	14
TSI	Ebot	597	2	0	Ebot	605	2	14
TSI	Eglo	330	2	0	Eglo	365	2	14
TSI	Eglo	300	2	0	Eglo	238	1	14
TSI	Eglo	300	1	0	Eglo	532	3	14
TSI	Eglo	333	1	0	Eglo	354	2	14
TSI	Eglo	262	1	0	Eglo	245	1	14
TSI	Eglo	280	2	0	Ebot	589	2	14
TSI	Eglo	230	1	0	Eglo	170	1	14
TSI	Eglo	270	1	0	Eglo	446	2	14
TSI	Eglo	314	2	0	Eglo	243	1	14
TSI	Eglo	325	2	0	Eglo	168	1	14
TSI	Eglo	330	2	0	Eglo	172	1	14
TSI	Eglo	397	2	0	Eglo	211	1	14
TSI	Eglo	380	2	0	Eglo	153	1	14
TSI	Eglo	193	1	0	Eglo	331	1	14
TSI	Eglo	230	1	0	Eglo	303	1	14
TSI	Eglo	325	2	0	Eglo	155	1	14
TSI	Eglo	490	2	0	Eglo	259	1	14
TSI	Eglo	630	3	0	Eglo	165	1	14
TSI	Eglo	229	1	0	Eglo	398	2	14
TSI	Eglo	520	3	0	Eglo	262	1	14
TSI	Eglo	450	3	0	Eglo	520	2	14
TSI	Eglo	160	1	0	Eglo	224	1	14
TSI	Eglo	162	1	0	Eglo	156	1	14
TSI	Eglo	222	1	0	Eglo	182	1	14
TSI	Eglo	210	1	0	Eglo	217	1	14
TSI	Esie	445	2	0	Eglo	185	1	14
TSI	Esie	810	3	0	Eglo	197	1	14
Integrated	Aflo	561	1	15	Alit	168	1	16
Integrated	Alit	190	1	15	Aflo	565	1	16
Integrated	Alit	159	1	15	Alit	229	1	16
Integrated	Alit	161	1	15	Alit	194	1	16
Integrated	Alit	162	1	15	Alit	170	1	16
Integrated	Alit	165	1	15	Alit	161	1	16
Integrated	Alit	165	1	15	Alit	188	1	16
Integrated	Alit	175	1	15	Alit	153	1	16
Integrated	Alit	177	1	15	Alit	150	1	16
Integrated	Alit	181	1	15	Alit	214	1	16
Integrated	Alit	181	1	15	Alit	160	1	16
Integrated	Alit	185	1	15	Alit	188	1	16
Integrated	Alit	195	1	15	Alit	235	1	16
Integrated	Alit	209	1	15	Alit	181	1	16
Integrated	Alit	212	1	15	Alit	150	1	16
Integrated	Alit	236	1	15	Alit	172	1	16
Integrated	Alit	241	1	15	Alit	209	1	16

Integrated	Alit	242	1	15	Alit	247	1	16
Integrated	Alit	186	1	15	Alit	179	1	16
Integrated	Alit	185	1	15	Elon	924	1	16
Integrated	Alit	168	1	15	Elon	736	1	16
Integrated	Elon	155	1	15	Alit	168	1	16
Integrated	Elon	683	1	15	Alit	159	1	16
Integrated	Elon	749	1	15	Alit	251	1	16
Integrated	Elon	602	1	15	Elon	688	1	16
Integrated	Elon	934	1	15	Emue	370	1	16
Integrated	Emue	185	1	15	Alit	194	1	16
Integrated	Emue	170	1	15	Emue	360	1	16
Integrated	Emue	353	1	15	Emue	200	1	16
Integrated	Emue	360	1	15	Emue	185	1	16
Crown	Afal	192	1	30	Afal	198	1	30
Crown	Afal	194	1	30	Afal	168	1	30
Crown	angflo	276	1	30	Afal	190	1	30
Crown	Ebos	715	1	30	Aflo	278	1	30
Crown	Ecup	198	1	30	Ebos	720	1	30
Crown	Elon	271	1	30	Ecup	231	1	30
Crown	Elon	560	1	30	Elon	395	1	30
Crown	Elon	606	1	30	Elon	295	1	30
Crown	Elon	479	1	30	Elon	339	1	30
Crown	Elon	632	1	30	Elon	478	1	30
Crown	Elon	320	1	30	Elon	275	1	30
Crown	Elon	557	1	30	Elon	454	1	30
Crown	Elon	398	1	30	Elon	567	1	30
Crown	Elon	284	1	30	Elon	645	1	30
Crown	Elon	445	1	30	Elon	559	1	30
Crown	Emue	804	1	30	Emue	475	1	30
Crown	Emue	191	1	30	Emue	213	1	30
Crown	Emue	463	1	30	Emue	809	1	30
Crown	Emue	607	1	30	Emue	552	1	30
Crown	Emue	809	1	30	Emue	628	1	30
Crown	Emue	562	1	30	Emue	839	1	30
Crown	Emue	888	1	30	Emue	183	1	30
Crown	Emue	643	1	30	Emue	614	1	30
Crown	Emue	546	1	30	Emue	648	1	30
Crown	Emue	607	1	30	Emue	475	1	30
Crown	Emue	464	1	30	Emue	554	1	30
Crown	Etri	233	1	30	Etri	835	1	30
Crown	Etri	610	1	30	Etri	384	1	30
Crown	Etri	226	1	30	Etri	237	1	30
Crown	Etri	388	1	30	Etri	614	1	30