3. RESULTS AND DISCUSSION

3.1 REVIEW OF METHODS

3.1.1 Broad forest class mapping

Four interpreters, including the senior API person, were assigned to mapping broad forest vegetation classes for two to three months. Only interpreters who could demonstrate experience in identifying and mapping forest eucalypt canopy floristics on the NSW South Coast and Tablelands were selected (Appendix 9.9). During the final weeks these API assisted with growth stage mapping, nomenclature auditing and API validation . A technical officer supporting API split field observation time between the interpreters. Two additional interpreters completed one 1:25,000 map sheet each. Approximate time to complete one map sheet was between five to ten days.

Broad forest vegetation classification mapping methodology was overly ambitious within allowed time and resources. In hindsight a reduction in the final level of mapping would be preferable. This would have allowed a more timely completion and opportunities to undertake better agreement assessments.

Broad forest vegetation class mapping was completed for the entire Eden CRA area except in the Puen Buen and Yankees Gap 1:25,000 map sheets. Remote, steep locations with little access on conserved tenure gave these areas the lowest priority for capture. By not capturing the information the project was able to meet API-EWG and SFNSW priorities for completing growth stage mapping and validation for the entire study area on time and on budget.

There are currently too many level three attributes for practical use. Much of this could be simplified by exporting and storing the information within a database.. This would enable multiple codes within polygons without considering every combination of codes unique (i.e. code 13/15 is the same as 15/13 however they are considered unique in the GIS layer). The inclusion of unique RN17 codes added to the problem. These problems have been noted and a simplified forest class layer has been developed for other CRA areas in NSW by the API-EWG.

3.1.2 Growth stage mapping

Two interpreters were assigned to growth stage mapping. Both interpreters had over three years experience in growth stage and floristic mapping for the Department of Environment and Natural Resources, Victoria. A technical officer in support, split field observation time between the two interpreters. All interpreters completed stereoscopic testing and technical typing assessment by senior interpreter. During their first week of employment a two-day field calibration exercise and extensive reviews of API mapping occurred. Following the first week, supervision of the API relaxed though desktop audits and field supervision by NPWS staff continued. When available the statewide API manager reviewed work as did SFNSW Senior interpreters.

3.1.3 Nomenclature auditing

Two interpreters were employed for six weeks to complete nomenclature audits. Nomenclature audits prior to capture were an essential step. They resolved a lot of minor errors that could have caused considerable delays in digital capture. However they were unable to find all errors and it was necessary to send the API Auditors to work with the scanning contractors to resolve API complications at the site of data capture.

3.1.4 Digital capture

Digital capture was split between two contractors. One contractor captured 70% of the area (15 map sheets) using technique 1: scanning capture. The other contractor captured 30% (ten map sheets) and used technique 2: manual digitising.

Work and time required to complete capture was under-estimated. Total time required was approximately one month per contractor. No appreciable difference was found between the accuracy and competence of either contractors or techniques.

More time was required to test and review digital capture techniques. These reviews were essential in removing bugs within the rectification software and scanning steps.

Digital capture contractors allocated control as specified without problems or loss of accuracy. Their total responsibility for control and spatial accuracy removed any conflict between interpreters and digital capture contractors.

The capture of broad forest vegetation classes was relatively straight forward. The only problem was with the large number of unique attributes. This could be improved by providing a total possible list of attributes prior to digital capture. This would remove many erroneous labels from being fitted. This is also true for growth stage labels.

The capture of growth stage edits was not straight forward and cost considerable time and possible accuracy. A pilot test of the growth stage editing procedure would have greatly simplified and expedited the process. Even where the information was manually digitised it would have been faster, cheaper and less troublesome to recapture the data rather than digitally edit the original digital BOGMP layer. This is especially the case when the digital BOGMP contains edits that are not transcribed onto the BOGMP overlays and where the north-south photographic runs meet the east-west photographic runs.

3.1.5 Final GIS collation

Final GIS collation required careful consideration and high levels of GIS expertise. As such the use of the API Manager and NPWS GIS Division staff and technology resources was highly appropriate. It was at this stage also that the project officer for old growth mapping became involved in the process (NPWS, 1997).

The collation of the broad forest vegetation maps was relatively straight forward. Minor concerns were: for the large number of unique broad forest vegetation classes that needed to be sorted; creating additional attribute columns to assist in manipulating a very large dataset; and stitching joins across map sheet boundaries. There were relatively very few boundary inconsistencies and only a few were not resolvable.

Some concern was raised as to the GIS quality of the digital RN17 provided. Considerable sliver and intersection error seemed to be enclosed in the layer, especially between boundaries of different RN17 mapping projects. This project was not expected to have to correct these layers and no resources were allocated for this in the proposal. As a result these errors could not be corrected.

Likewise some concern was also expressed about the poor detail and inconsistent control of the final non-eucalypt plantation layer that was provided by SFNSW. The merging of digital layers obtained using differing or even the same control technique created inconsistencies when matching new digital layers to existing. These inconsistencies could be greater than spatial accuracy required for this project. This appeared to be the case with the plantation layer. Where possible these inconsistencies were cleaned up in the GIS editing but if the inconsistencies were not resolvable without field validation no attempt was made to resolve the differences.

3.2 REVIEW OF FINAL BROAD FOREST VEGETATION MAP

No field validation or desktop validation was completed for the final broad forest vegetation map. No independent agreement assessment was available for this map.

General discussions with senior interpreters suggest the accuracy of coding to be less than RN17 typing because of less time being available for field validation during the project.

A general increase to level two mapping is recommended for general use of this map.

Further complications were caused by the large number of unique codes, the large size of the layer and the incompatibility between RN17 and broad forest vegetation typing. It is recommended that future capture of broad forest classes information for CRAs and other regional studies start with simplified levels of classification before developing complex hierarchies. This would improve the accuracy and coverage of the information for forest vegetation modeling. The API-EWG is considering the implications of this for other CRAs.

3.3 REVIEW OF FINAL GROWTH STAGE MAP

3.3.1 General overview of API agreement assessments

The significance of the results of API checking and agreement assessment requires careful consideration. In broad terms while it is necessary to tabulate numbers of samples or polygons and to analyse the qualities of different categories of checks or results, it can be quite unwise to attach absolute meaning to such numerical analyses. API attempts to compartmentalise forests which, especially in eucalypt forests, may be very heterogeneous without providing discrete boundaries between stands.

It is also necessary to reflect on the nature of API and the decision pathways when considering independent checks of its products. The difference in results of checking techniques, between office interpreted and field validation are not quantifiable against an absolute measurement. Seemingly serious differences may be relatively trivial however it is difficult to separate the trivial differences from the serious ones. All non-agreements tend to be assessed and scored in the same way regardless of their contribution to serious errors.

3.3.2 Summary

In this project it was feasible only to check a relatively small sample using field validation and desktop audit. The results indicate trends rather than statistically meaningful data. At the completion of the project, polygon agreement check by experienced interpreters of 1782 polygons from 56 photographs was completed. This represents 6% of all the photographs analysed or approximately 9% of photographs containing forests.

Initial results indicated only a fair agreement between the field validation and the growth stage map. However there appeared to be no bias in the disagreements regarding regrowth or senescence (Table 3a).

TABLE 3A: SUMMARY COLLATED INDEPENDENT AGREEMENT ASSESSMENT FOR ATTRIBUTES OR FINAL GROWTH STAGE MAP, EDEN CRA

Code Group from Old Growth Project*	Number of Polygons	
	Growth Stage Map	Independent Validator
tA, tB, sA	528 (30%)	505 (28%)
tC, sB, sC	891 (50%)	891 (50%)
e	261 (15%)	297 (17%)
L	102 (5%)	89 (5%)
Total	1782 (100%)	1782 (100%)

* Refer to Table 3b for key to codes and NPWS 1996 for further detail.

Code agreement between independent validators and the growth stage map occurred in 62.9% of all the polygons checked. No bias toward over or under estimating regrowth (OER or UER) or senescent contribution was encountered (OER 18.7%, UER 18.4%).

3.3.3 Explanation of code agreement matrices

Overall growth stage code agreement checks are in Table 3b. The horizontal axis represents the growth stage code on the final CRA map. The vertical access represents the code as assessed by the API validator. The column labelled “total” is the sum of all equally coded polygons by the API.
The column labelled “OER” is the sum of all polygons in the growth stage map that the API validator considered the percentage contribution of regrowth crowns was over-estimated OR senescent crowns under-estimated.
The row labelled “total” is the sum of all equal coded polygons in the final CRA growth stage map.
The row labelled “UER” is the sum of all polygons in the growth stage map that the API validator considered that the percentage contribution of regrowth crowns was under-estimated OR senescent crowns over-estimated.

TABLE 3B: COLLATED INDEPENDENT AGREEMENT ASSESSMENT OF INDIVIDUAL POLYGONS FOR ATTRIBUTES OF FINAL GROWTH STAGE MAP, EDEN CRA

		Attributes on Final Growth Stage Map											
		tA*	tB*	tC*	sA*	sB*	sC*	eA*	eB*	eC*	L*	Total	OER**
Attributes from Pi Validation	tA*	59	25	4	11	4	1	0	0	0	0	**104**	**45**
	tB*	21	236	42	14	71	20	0	2	2	0	**408**	**151**
	tC*	1	34	130	1	11	39	2	0	2	2	**222**	**57**
	sA*	0	1	0	14	0	1	0	0	0	0	**16**	**1**
	sB*	8	21	9	17	185	17	2	2	3	0	**264**	**24**
	sC*	3	30	55	5	42	222	7	13	27	1	**405**	**48**
	eA*	0	0	0	0	0	2	0	0	0	0	**2**	**0**
	eB*	0	0	0	0	0	0	1	2	0	0	**3**	**0**
	eC*	1	2	5	0	3	20	6	28	189	2	**256**	**2**
	L*	0	0	2	1	5	1	0	3	6	84	**102**	
	Total	**93**	**349**	**247**	**63**	**321**	**323**	**18**	**50**	**229**	**89**	**1782**	**328**
	UER* **	**34**	**88**	**71**	**23**	**50**	**23**	**7**	**31**	**6**		**333**	

* tA = <10% Regrowth/ >30% Senescence; tB = <10% Regrowth/ 10-30% Senescence; tC = <10% Regrowth/ <10% Senescence; sA = 10-30% Regrowth/ >30% Senescence; sB = 10-30% Regrowth/ 10-30% Senescence; sC = 10-30% Regrowth/ <10% Senescence; eA = >30% regrowth/ >30% senescence; eB = >30% regrowth/ 10-30% senescence; eC = >30% regrowth/ <10% senescence; L = Recently Logged Forest. Refer to Appendix 9.5 and NPWS 1996 for further detail.
** OER = Over Estimated Regrowth
*** UER = Under Estimated Regrowth

Table 3c indicates the sum of polygons where the API validator agrees with the growth stage map, the sum of OER and UER polygons and the total sum of polygons checked.
Summary tables provide raw numbers and percentages on agreement / disagreements with variance.

TABLE 3C: SUMMARY COLLATED AGREEMENT ASSESSMENT OF ATTRIBUTES, FINAL GROWTH STAGE MAP, EDEN CRA

Agreed	OER*	UER**	Total
1121	328	333	1782
62.9%	18.4%	18.7%	100.0%

* OER = Over Estimated Regrowth
** UER = Under Estimated Regrowth

3.3.4 Interpretation of code agreement matrices (Appendix 9.6)

Relative lineage of growth stage map

The term “lineage” is used in this report to define the methods used to create and subsequently modify a polygon. Of the 1782 polygons checked 42.1% (750) had not been changed from the BOGMP layer, 45.8%

(817) had been changed and 12.1% (215) were new polygons inserted. These relative ratios between polygons of different lineage do not accurately reflect the overall ratios in the final growth stage map. This is because re-evaluated BOGMP polygons (BOGMP polygons with codes changed) were specifically targeted in the code agreement assessment. This will have increased their relative occurrence in the agreement matrices.

Outcome of assessments between polygons with different lineage

Code agreement assessments were undertaken to compare agreement assessment results between polygons with different lineage in the final growth stage map. Validation of unchanged BOGMP polygons was a by catch of a validation procedure established to provide an accuracy statement for BOGMP polygons that had a code change.

A comparison between the final level of agreement of changed and unchanged codes is invalid. This is because the original codes prior to change have not been subjected to the same validation procedure as the changed codes. It is conceivable that the changing of the codes could have improved the overall accuracy of changed polygons from a previously low level. This still needs to be tested.

There was a 66.7% agreement with the 750 BOGMP polygons that remained unchanged. More than twice as many polygons tended to over-estimate regrowth than under-estimate it. This represents a significant bias towards over-estimating regrowth contribution (OER 23.1%, UER 10.3%).

There was a 61.0% agreement with the 817 re-evaluated BOGMP polygons. There was a small bias towards under-estimating regrowth contribution (OER 15.3%, UER 23.1%). No level of agreement for the original BOGMP codes was recorded for these polygons.

There was a 57.2% agreement with the 215 new polygons and codes introduced into the final growth stage map. These polygons had a significant bias towards over-estimating regrowth contribution (OER 31.2%, UER 11.61%). The smaller sample size may have contributed to the wider variation around agreement.

Outcome of API validation checks between different parts of Eden CRA area

Results from the API validation were collated into totals relevant to 1:25,000 map sheets. Levels of polygon agreement were divided into low (less than 60%) and fair (greater than 60%). Fair levels of agreement between API validators and the final growth stage map occurred on 13 of the 25 map sheets checked including seven with greater than 75% agreement. No bias was evident in two of these map sheets. Four map sheets had a bias toward over-estimating and seven under-estimated the contribution of regrowth to canopy (Table 3d). Beware that comparing changed to unchanged polygons is invalid because the BOGMP codes that existed prior to changes have not been subject to the same validation assessment.

TABLE 3D: COLLATED POLYGON AGREEMENT ASSESSMENT RESULTS BETWEEN 1:25,000 MAP SHEETS GROWTH STAGE ATTRIBUTES, EDEN CRA

	Original BOGMP	Re-evaluated BOGMP	New Polygon & Code	ALL COMBINED
FAIR	16	14	11	13
LOW	9	11	14	12
NO BIAS	6	6	14	4
UER	18	9	3	14
OER	1	10	8	7

Low levels of polygon code agreement between API validators and the final growth stage map occurred on 12 map sheets. Only one of these, Narooma, was very low. Only a very small sample was taken on this map sheet. No bias was evident on two of these map sheets. Three map sheets over-estimated and seven under-estimated the regrowth contribution. Caution must be used when considering these results because of the relatively low level of sampling that has occurred in each map sheet.

Review of outcomes

On commencement of the project it became obvious that there were more inaccuracies in the BOGMP than originally were thought to exist. These inaccuracies were usually obvious (e.g. including Acacia and Casuarina species as eucalypt regrowth, mistaking mature silvertop ash for regrowth, including cleared land in regrowth, and including wattle shrub in rainforest). It also became obvious the API methodology for updating the BOGMP map was complex and confusing to interpreters and digital capture contractors.

The complicated procedure for editing BOGMP overlays probably contributed to increasing levels of non-agreement along with original inaccuracies in the BOGMP. It also required the interpreters to look through two overlays for recording edits to the BOGMP. This reduced definition of the photographic image, further contributing to complications.

It is recommended for future work that the final growth stage layer be re-interpreted and transcribed onto new overlays in its entirety. The old BOGMP overlays could be used as a validated guide to assist interpretation. No additional resources would be required because this simplified procedure would reduce API and GIS editing time and cost. This is now the preferred procedure of the API-EWG for future CRA API projects.

Variability in growth stage sampling techniques used for field validation may also give a large variation in results. Current indications are that the CRA API technique of basal area sweeps consistently over-estimates the contribution of regrowth to canopy relative to point to plant sampling. Both these techniques appear to under-estimate the contribution of senescent and mature trees to the canopy when compared to transects of relative crown canopy. The agreed standard for all future CRA API projects is point to plant sampling. However it was the basal area sweep technique that was used in this project. This may have contributed to over-estimating the relative regrowth contribution in final growth stage polygons.

A consequence of the complications mentioned above make for inconclusive comparisons between an API layer independently validated by field checks with desktop audits and independent desktop only audits.

The implications of this project's results are that BOGMP agreement outcome could not be replicated using the validation process adopted for this project. This may infer limitations in the validation process used by the BOGMP that could have been improved with greater field validation.

Prior to beginning this project no field validation had been undertaken for the BOGMP. It was nevertheless accepted that this layer could be simply and accurately modified to fit statewide API-CRA growth stage specifications. Indeed very few codes were expected to change.

The BOGMP was collated from work done by six interpreters in a very short period. The desktop audit principally confirmed API coding without undertaking systematic field validation. In essence it was an API validation of API. Also edits were made to the BOGMP layer, during desktop validation, that were never recorded onto the photographic overlays. This meant that the digital BOGMP was different to the BOGMP being used by the CRA interpreters in some places. There was no practical way to correct for this.

Results from the accuracy assessment phase of this project are not easy to interpret in absolute terms. At a polygon code agreement level there appears to be only fair agreement between interpreters and validators. However at a grouped growth stage level the agreement is very high.

An assessment of the value of validation needs to be considered. Time and resources required for validation may be better used by interpreters during the re-evaluation of every polygon in creating the original map. This re-evaluation with field checking is constantly validating the final map.

Agreement assessment results for individual polygons also need to be considered in view of the use of the API map. For the growth stage map API classes were lumped (Table 3a) then modelled with logging history and site productivity layers to create the final old growth map. It appears from agreement assessment that the regional mix of API codes is very good. However, at a local level the likelihood of polygon code agreement to a somewhat ill-defined "absolute" growth stage statement is less likely. Managers should be wary of imposing rigid rules to simple codes at local scale without some form of specific polygon validation.

Finally it is important to compare these results with BOGMP results. They were both different projects, undertaken and validated differently. While the intent of the final results was similar the specifications were quite different. No doubt both have their strengths and shortcomings.

3.3.5 Disturbance history

Generally there was a high level of agreement (89.9% of 1782) between API validators and final growth stage map (Table 3e). There was a bias that appeared to under-estimate evidence of logging (236 polygons from API validators, 151 in final growth stage maps) and over-estimate evidence of fire (23 polygons from API validators, 36 in final growth stage map).

TABLE 3E: COLLATED AGREEMENT ASSESSMENT OF DISTURBANCE CODES WITHIN FINAL GROWTH STAGE MAP, EDEN CRA

Final Growth Stage Map / API Validation	No evidence of Disturb-ances	Evidence of Logging	Evidence of Fire	**Total**
No evidence of Disturbances	1473	25	25	1523
Evidence of Logging	116	119	1	236
Evidence of Fire	6	7	10	23
Total	1595	151	36	1782

Interpreters doing the final growth stage map only recorded evidence of a disturbance where it was obvious on aerial photography. The reason for this was to improve the confidence and agreement of applying API techniques to forest stands that could not be field validated because of resource constraints. This removed the impact of disturbance information being inferred from information not visible on the photography. Such extrapolations to unknown forest stands using API only could be erroneous.

An additional 116 polygons were found to have some evidence of logging that was not recorded in the final growth stage maps. This represents 6% of the total 1782 polygons checked. The principal reason for this was that API validators were able to use the field validation technique to observe evidence of logging that was not discernible in the canopy.

A more carefully structured validation procedure should be considered. Recording evidence of disturbance provides no assessment of the extent and impact of a disturbance. This may confuse older or minor disturbances only visible in the field with more extensive and recent disturbances obvious from 1:25, 000 aerial photography. Further thought should be given to the level of disturbance that is important to measure. This relates to what disturbance tagging will be used in forest ecosystem, old growth and fauna modelling. The API-EWG is considering these issues prior to commencing other CRAs in NSW.

Every attempt was made to meet the objectives specified in the original project proposal. Principal reasons why changes to the original project proposal occurred were:

- three month delay in approval of project proposal;
- project commenced before completion of field trials;
- ambitious timeframe considering mapping objectives;
- over-estimation of digitally available Research Note 17 mapping; and
- over-estimation of available digital growth stage and broad forest typing, which after evaluation did not meet API specifications for the project.

Where variations did occur the API-EWG was notified and they endorsed best alternative options.

3.4 METADATA STATEMENTS

Metadata statements for the API floristics, growth stage and historical forest disturbance are included at Appendix 9.10.