



Hydro Tasmania
the renewable energy business

**Southwood macroinvertebrate
monitoring, autumn 2005
report**



Hydro Tasmania
the renewable energy business

Prepared By: Adam Uytendaal
HYDRO ELECTRIC CORPORATION
ARBN 072 377 158
ABN 48 072 377 158
4 Elizabeth Street, Hobart
Tasmania, Australia

Report No: 120847-050630AS
Rev. Status: FINAL
Date Issued: June 2005

DOCUMENT INFORMATION

JOB/PROJECT TITLE:

Southwood macroinvertebrate monitoring, autumn 2005 report

CLIENT ORGANISATION:

Newood Huon Pty Ltd

CLIENT CONTACT:

Dario Tomat

DOCUMENT ID NUMBER:

120847-050630AS

DATE:

27 July 2005

REV/DRAFT NO:

Final

JOB/PROJECT MANAGER:

Andrew Sampaklis

JOB/PROJECT NUMBER:

120731/120847

REVISION/DRAFT HISTORY:

REV	DATE	DESCRIPTION	PREPARED	REVIEWED	APPROVED
1	21 Jun 05	Final	Adam Uytendaal	Andrew Sampaklis	David Andrews

TABLE OF CONTENTS

1	INTRODUCTION	2
2	METHODS	3
3	RESULTS	3
4	CONCLUSIONS.....	10
5	REFERENCES	10
APPENDIX 1	AUTUMN SURVEY MARCH 2005 - SITE PHOTOGRAPHS	11
APPENDIX 2	SPRING SURVEY OCTOBER 2004 HABITAT ASSESSMENT	14
APPENDIX 3	AUTUMN SURVEY MARCH 2005 HABITAT ASSESSMENT	18
APPENDIX 4	PREDICTOR VARIABLES FOR SPRING, AUTUMN AND COMBINED SEASON AUSRIVAS RIFFLE MODELS FOR THE 2004 - 2005 SEASONS	22
APPENDIX 5	BANDING FOR AUSRIVAS O/E SCORES.....	23

1 INTRODUCTION

Assessment of river health using AUSRIVAS (AUStralian RIVer Assessment System) rapid bio-assessment methodology is a component of the Southwood Bioassessment program managed by Newood Huon Pty. Ltd. This report, the fourth report since monitoring commenced in November 2003, details the results of the spring and autumn benthic macroinvertebrate samples that were collected during October 2004 and March 2005 for the purpose of AUSRIVAS modelling.

AUSRIVAS is a nationally standardised bio-monitoring approach that uses aquatic macroinvertebrates to assess river condition. AUSRIVAS models are a rapid bio-assessment tool for measuring river health and provide a biological indicator of the health of a waterway. AUSRIVAS assessments monitor the response of a particular macroinvertebrate community to changes in river condition and water quality to be monitored and assessed.

The resulting AUSRIVAS O/E score provides an assessment of river health by comparing the diversity of the community against what would be expected in a minimally disturbed stream with a similar location and physical characteristics, independent of human activities (Coysh *et al.*, 2004). Such a site is termed the reference site and the AUSRIVAS O/E score is computed as the observed number of taxa divided by the expected number of taxa as determined by the model.

AUSRIVAS assessments of river health are based on the collection of a representative sample of the macroinvertebrate faunal assemblage at the site in question. Comparisons are made between observed faunal assemblages to the faunal assemblage predicted by the AUSRIVAS models. The predicted faunal assemblage reflects that of a similar site in the region in a natural or un-impacted condition.

AUSRIVAS sampling allows for broad condition comparisons to be made between sites as well as changes in river health at a specific site or range of sites over time. The use of biological assessment of river condition promotes understanding of longer term ecosystem processes and the impacts of natural and human related activities on physical, chemical and biological variables (Norris and Thoms, 1999).

The aim of the study was to continue with the collection of baseline macroinvertebrate data to assist in monitoring the environmental condition of the Huon River and Kings Creek in the vicinity of the Southwood complex on the Huon River. The collection of the 2004/2005 data set expands on the previous years data collected in spring and autumn of 2003 and 2004 respectively.

Three sites within the Huon River catchment relevant to the proposed Southwood site were sampled. These sites were:

- Kings Creek upstream of the confluence with the Huon River,
- Huon River upstream of the bridge at the Arve River confluence, and
- Huon River downstream of the Southwood development site.

2 METHODS

Hydro Tasmania Consulting collected macroinvertebrate samples from the three sites in the Huon River catchment on the 13th of October 2004 and the 9th of March 2005, representing the spring and autumn AUSRIVAS sampling periods respectively.

A single kick sample was collected from a 10 m length of riffle at each site that incorporated all the micro-habitats within the riffle habitat. The kick sample was collected with a 250 µm mesh net with a 280 x 340 mm opening. The sample areas remained consistent throughout the sampling regime. Standard habitat assessment and water quality data required for inclusion into the model were collected from each site (Appendix 2 and 3).

Kick samples were processed on site to facilitate live picking according to standard AUSRIVAS live picking protocols. Preserved pick samples were identified to family level upon return to the laboratory.

Both the individual taxa records for the spring and autumn sampling events were analysed independently as well as a combined taxa record. Predictor variables necessary for inclusion into the models were determined from the habitat sheets. The predictor values used for each site for each season are outlined in Appendix 4. Both AUSRIVAS O/E values and O/E SIGNAL values were computed and used in the assessment of riverine health.

The O/E SIGNAL score is an indicator of the pollution sensitivity of the community at the test site. An O/E SIGNAL equal to 1 reflects a macroinvertebrate community as pollution sensitive as the reference site community. An O/E SIGNAL >1 reflects a test site community more pollution sensitive than the reference site. An O/E SIGNAL score <1 reflects a faunal assemblage less sensitive or more tolerant to pollution than the reference. The AUSRIVAS O/E SIGNAL score is an additional means of interpreting the model output in regards to the health of the macroinvertebrate community.

3 RESULTS

A summary of total taxa collected for each site for each season is tabulated in Table 1. Table 1 outlines in details the taxa that were predicted to occur at the sites by the AUSRIVAS models but were not detected, the taxa that were predicted to occur and were detected and the taxa that were not predicted to occur but were detected.

A total of 34 separate taxa were collected across the three sites from both the spring and autumn sample trips. At the Kings Creek site a total of 19 taxa were recorded in autumn 2005, up from 16 taxa recorded in autumn 2004. Twenty five taxa were recorded from the Huon River above the Arve River confluence, which is a increase of 4 taxa from autumn 2004. The number of taxa collected at the Huon River downstream from the Southwood development site was similar to the previous years sampling event with 21 taxa recorded as opposed to 20 taxa in 2004.

For the combined season model, there were 11 taxa predicted to occur in the combined seasons samples for Kings Creek that were not detected, compared to a total of 4 and 7 predicted taxa that were not detected in the upstream and downstream Huon River sites respectively. The increased

number of predicted but not detected taxa for Kings Creek reduced the O/E score for this site significantly when compared to the Huon River sites (discussed in more detail below).

As was found with the 2003-04 surveys, Dipterans (true flies) were a significant component of the macroinvertebrate community at all sites sampled for both the spring and autumn samples. The Dipteran Chironomid larvae - Orthocladiinae and Chironominae dominated the Kings Creek samples, compared to the Dipteran Chironomid larvae - Podonominae and the Dipteran fly larvae – Simuliidae dominating the Huon River sites.

The Ephemeropteran mayfly - Leptophlebiidae and the Trichopteran caddis fly - Hydrobiosidae were dominant at all three sites and were collected in large numbers. The Plecopteran stonefly - Gripopterygidae was also present at all three sites for the spring samples but was absent for the autumn sample from the upstream Huon River site and only a single individual was collected for the autumn sample from the lower Huon River site.

Included in Table 1 are the SIGNAL scores for each individual taxa. SIGNAL or Stream Invertebrate Grade Number, is an index of the sensitivity of the taxa to pollution. A SIGNAL score of 10 indicates a taxa that is highly sensitive to pollution, while a low SIGNAL score such as 2, indicates a taxa that is tolerant to pollution.

Table 1 Overview of the number of each individual taxa collected for both the Spring 2004 and Autumn 2005 sampling runs. Comparisons have been made between modelled predicted occurrence and actual occurrence for the AUSRIVAS Spring, Autumn and combined season models.

Taxa Predicted and Collected
 Taxa Predicted and NOT Collected
 Taxa Collected but NOT Predicted

SIGNAL Score	Order	Family	Spring 2004 Model			Autumn 2005 Model			Combined Season Model		
			Ki Ck	H US	H DS	Ki Ck	H US	H DS	Ki Ck	H US	H DS
2	Platyhelminthes	Turbellaria					3		3		
5	Nematomorpha	Gordiidae				2			2		
4	Mollusca	Hydrobiidae						2		2	
5	Mollusca	Sphaeriidae				1			1		
2	Oligochaeta	Oligochaeta	5	5	34	2	21	11	7	26	45
6	Acarina	Acarina	0			0		2	0	0	2
4	Amphipoda	Paramelitidae		1	1	0		17	0	1	18
6	Coleoptera	Scirtidae	0	1	1	2	14	4	2	15	5
7	Coleoptera	Elmidae – adults	13	3	6	2	1	23	15	4	29
7	Coleoptera	Elmidae - larvae	0	0	5		1	5	0	1	10
6	Coleoptera	Psephenidae		1					0	1	0
5	Diptera	Tipulidae	4	1	0	3	4		7	5	0
10	Diptera	Blephariceridae	1	5	11		0	0	1	5	11
4	Diptera	Ceratopogonidae									
5	Diptera	Simuliidae	2	42	39	0	14	0	2	56	39
8	Diptera	Athericidae	1						1		
5	Diptera	Empididae					1			1	
6	Diptera	Diamesinae							0	0	0
6	Diptera	Podonominae	0	24	38	0	0	1	0	24	39
4	Diptera	Tanypodinae	1			1			2		
4	Diptera	Orthoclaadiinae	26	1	4	9	0	0	35	1	4
3	Diptera	Chironominae	7	0	0	5	2		12	2	0
5	Ephemeroptera	Baetidae	0	3	1		2	4	0	5	5
8	Ephemeroptera	Leptophlebiidae	11	54	20	43	95	50	54	149	70
3	Hemipteran	Veliidae							1		
4	Odonata	Aeshnidae							0		
10	Plecoptera	Eustheniidae	7	11	7	16	12	11	23	23	18
10	Plecoptera	Austroperlidae					2			2	0
8	Plecoptera	Gripopterygidae	8	15	7	6	0	1	14	15	8
6	Plecoptera	Notonemouridae				3			3		
8	Trichoptera	Hydrobiosidae	8	22	16	8	8	10	16	30	26
9	Trichoptera	Glossosomatidae								0	0
6	Trichoptera	Hydropsychidae						13	0	0	13
7	Trichoptera	Conoesucidae	0	1	7	0		8	0	1	15
8	Trichoptera	Helicopsychidae					1			1	
9	Trichoptera	Calocidae	9	1	0				9	1	0
8	Trichoptera	Philorheithridae		1		0	1	3	0	2	3
6	Trichoptera	Leptoceridae	0	3	1	0	18	9	0	21	10

H DS : Huon River downstream of the Southwood development site. H US : Huon River upstream of the Arve River bridge. Ki Ck : Kings Creek upstream of the Huon River confluence.

As mentioned previously a greater number of macroinvertebrate taxa were recorded in 2004-05 compared to 2003-04. These taxa were not key taxa in the AUSRIVAS modelling and had no bearing on the final O/E scores for each site. The new taxa detected were Platyhelminthes - Turbellaria from the upstream Huon River site; Nematomorpha – Gordiidae from the Kings Creek site; Mollusca – Hydrobiidae from the downstream Huon River site and Mollusca - Sphaeriidae from the Kings Creek site; and two Dipterans – Athericidae from Kings Creek and Empididae from the upstream Huon River site.

The spring, autumn and combined season AUSRIVAS modelling results are presented in Tables 2 – 4 and include the O/E scores and corresponding environmental classification.

Results of the AUSRIVAS modelling for all three sites for the spring samples were generally good. The downstream Huon River site had a high O/E score of 1.18 which placed it in the X band as being more diverse than reference condition.

The upstream Huon River site was found to have a species diversity comparable to reference condition which was similar to the result of the 2003 spring survey. The O/E score for Kings Creek had dropped to 0.83 which placed it over the threshold for the A band into the B band (Figure 1) and was thus deemed to be significantly impaired. The difference in O/E score between the 2004 spring survey and the 2003 spring survey may be attributed to the failure to detect a few key AUSRIVAS taxa in the latest survey that were detected in the 2003 spring survey. The taxa of interest being the Trichopteran – Leptoceridae and the Coleopteran - Elmidae larvae. A single individual of each of these taxa was collected in the 2003 survey inturn increasing the O/E score.

In terms of O/E scores, several changes were evident in the autumn 2005 survey compared to the autumn 2004 survey. The upstream and downstream Huon River sites exhibited opposite trends in relation to diversity bands. The increased O/E score for the downstream Huon River site (0.95) improved the environmental banding of this site to place it in the A band, compared to a reduced O/E autumn 2005 score for the upstream Huon River site of 0.84, to place it in the B band (Table 3; Figure 2).

The results for the autumn 2005 survey on Kings Creek were positive, with the O/E score increasing from 0.50 from autumn 2004 to 0.77 for the autumn 2005 survey. This increased the autumn environmental banding for Kings Creek from being a C band (severely impaired) to a B band (significantly impaired) (Table 3; Figure 2). The reason for the increased diversity of animals in Kings Creek for the autumn 2004 surveys may be due to increased water availability through the summer of 2004/2005, although comparisons of rainfall records for the area for this time period would need to be analysed to validate this notion. Alternatively, this trend may be due to natural variability in the macroinvertebrate assemblage, but it is difficult to conclude on this matter with the existing monitoring effort.

Results for the combined season samples indicate a minor decrease in O/E scores for the downstream Huon River site and a considerable decrease in O/E score for the Kings Creek site for the 2004/2005 survey when compared to the results of the 2003/2004 combined season model output (Figure 3). This is contrary to the upper Huon site, which showed a slight rise in O/E score,

although the rise is likely to be insignificant compared to the 2003-04 combined season O/E score. The downstream Huon River site fell within the B band category, reflecting a macroinvertebrate community significantly impaired when compared to reference. This needs to be interpreted with care as the O/E score of 0.86 for the downstream Huon site for the combined season survey is only 0.01 below the A band cut-off of 0.87 (Appendix 5).

The AUSRIVAS output for Kings Creek for the 2004-05 combined season model shows the freshwater biota at this site to be less diverse when compared to the predicted reference condition, with a low O/E score of 0.63 corresponding to a low B band rating (Table 4 and Figure 3). This score reflects substantially fewer aquatic invertebrate taxa than were predicted to occur at the site.

The decrease in O/E score from the 2003-04 to the 2004-05 Kings Creek combined season modelling output from 0.78 to 0.63 is likely to be attributed to the reduced O/E score recorded for the 2004 spring survey. The reduced macroinvertebrate diversity in Kings Creek in the spring of 2004 would have influenced the combined season O/E score considerably.

Table 2 Results of the AUSRIVAS analysis undertaken on the spring 2004 data.

Site	Season	O/E score	O/E SIGNAL score	Band	Classification
Huon u/s Arve	Spring 04	1.02	1.03	A	Reference condition
Huon d/s Sthwood	Spring 04	1.18	1.03	X	More Diverse than Reference
Kings Creek	Spring 04	0.83	1.03	B	Significantly impaired

Table 3 Results of the AUSRIVAS analysis undertaken on the autumn 2005 data.

Site	Season	O/E score	O/E SIGNAL score	Band	Classification
Huon u/s Arve	Autumn 05	0.84	0.98	B	Significantly impaired
Huon d/s Sthwood	Autumn 05	0.95	1.02	A	Reference condition
Kings Creek	Autumn 05	0.77	1.01	B	Significantly impaired

Table 4 Results of the AUSRIVAS analysis undertaken on the combined season 2004/2005 data.

Site	Season	O/E score	O/E SIGNAL score	Band	Classification
Huon u/s Arve	Combined 04/05	0.99	1.01	A	Reference condition
Huon d/s Sthwood	Combined 04/05	0.86	1.00	B	Significantly impaired
Kings Creek	Combined 04/05	0.63	1.02	B	Significantly impaired

Figure 1 Bandwidths and inferred condition for the AUSRIVAS spring season model output for the three sites sampled for the 2003 and 2004 sample years. Bandwidths correspond to those outlined in Appendix 5.

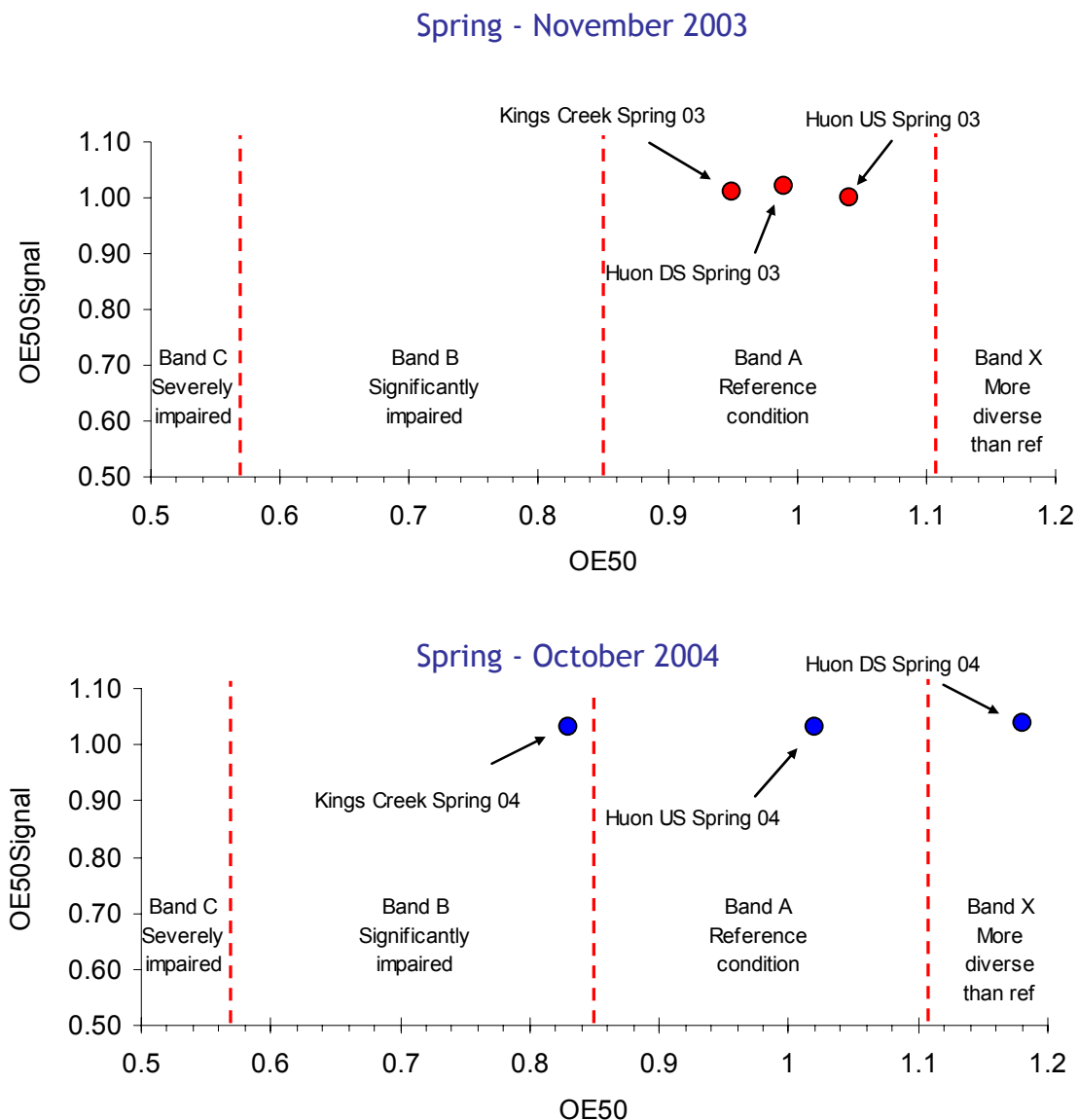


Figure 2 Bandwidths and inferred condition for the AUSRIVAS autumn season model output for the three sites sampled for the 2004 and 2005 sample years. Bandwidths correspond to those outlined in Appendix 5.

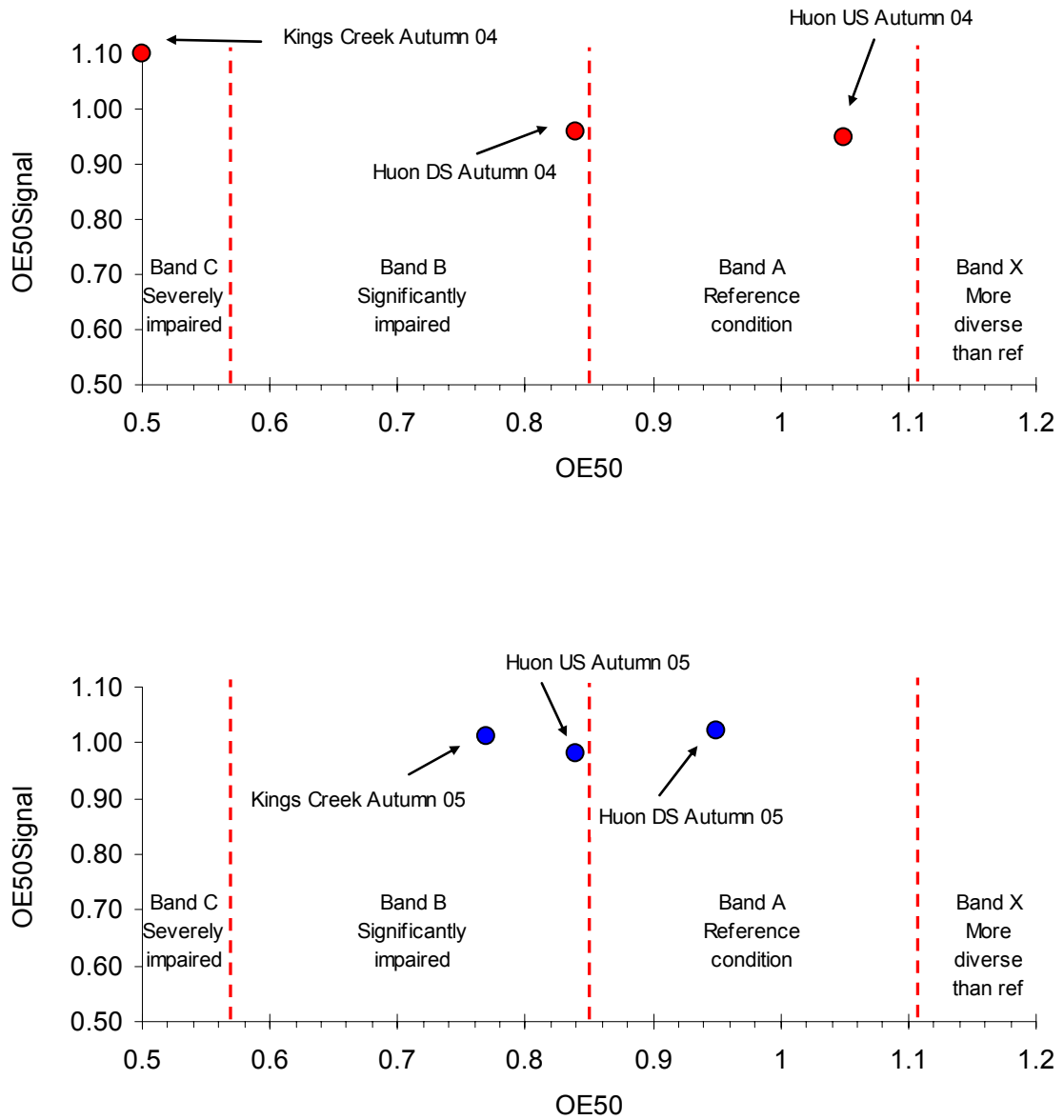
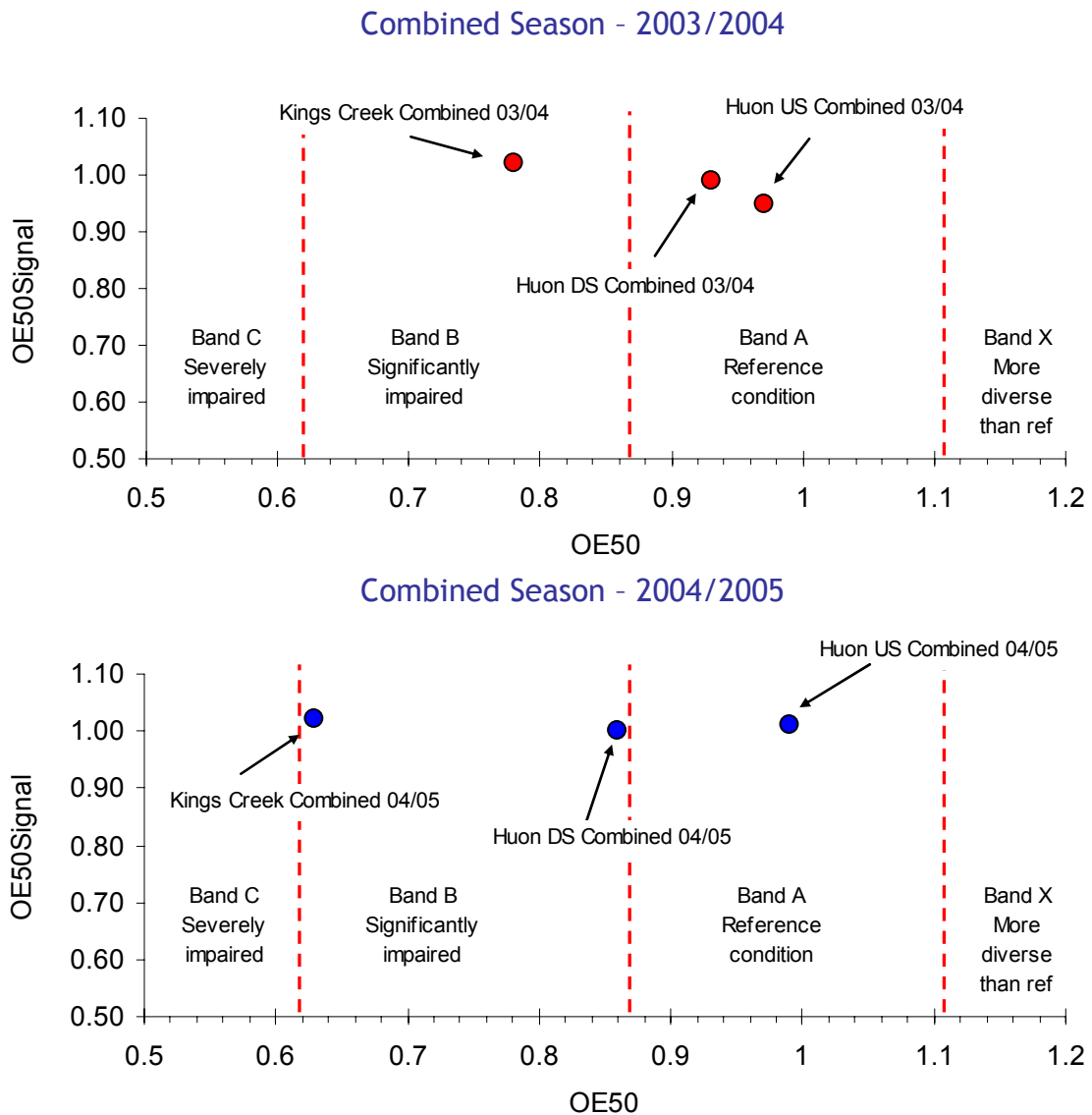


Figure 3 Bandwidths and inferred condition for the AUSRIVAS combined season model outputs for the three sites sampled for the 2003/2004 and 2004/2005 sample years. Bandwidths correspond to those outlined in Appendix 5.



4 CONCLUSIONS

Results from the spring survey conducted in October 2004 showed that all three sites had healthy macroinvertebrate communities.. Both the upstream and downstream Huon River sites were found to have macroinvertebrate communities comparable to reference sites. The Kings Creek site had a slightly reduced O/E score for the spring survey that placed it marginally over the threshold for the A environmental band into the B band. The macroinvertebrate community for this site may still be in good condition. The autumn surveys and modelling results returned lower O/E scores for all three sites although the degree of change was minimal.

The combined season model returned good results for both the Huon River sites with O/E scores being closely comparable to reference sites. The upstream Huon River site was in the A band and the downstream Huon River site just within the B band, although the degree of difference between the two sites remains largely insignificant.

The Kings Creek site had a reduced O/E score of 0.63 for the combined season model placing it slightly above the C band threshold (severely impaired) to be in the lower portion of the B band. As was concluded with the survey of 2003/2004, this is likely a consequence of the flow characteristics of the creek which appears to be intermittent towards the end of the summer season. This would limit the amount of available habitat and reduce habitat diversity likely resulting in reduced diversity and abundance of macroinvertebrates for the autumn surveys. Also, the failure to collect a few critical taxa in the spring survey of 2004 further reduced the O/E score for the combined season models.

The results of the Southwood Macroinvertebrate Monitoring Program using AUSRIVAS rapid bioassessment has continued to build on the existing data characterising baseline macroinvertebrate community composition for the Huon River in the proximity of the proposed Southwood development site. The results for the 2004-05 sampling seasons found macroinvertebrate community composition in the Huon River to be of good health with no evidence of impairment, with a high level of taxa representation across the macroinvertebrate community. The small tributary stream, Kings Creek, was found to have a reduced taxon richness reflecting a significantly impacted community. The reasons for this are likely due to the intermittent nature of flows within this small stream, although further monitoring effort and investigation would be needed to confirm this idea.

5 REFERENCES

- Barmuta, L.A., Chessman, B.C., and Hart, B.T. (1998) 'Interpreting the outputs from AUSRIVAS'. Occasional Paper 02/98. Land and Water Resources Research and Development Corporation. 67pp.
- Coysh, J., Norris, R., and Robinson, W. (2004) 'Review and development of aquatic macroinvertebrate protocols. Appendix 3 - Macroinvertebrates' Final Report Project R2004. Development of a Framework for the Sustainable Rivers Audit. Cooperative Research Centre for Freshwater Ecology.
- Norris, R.H. and Thoms, M.C. (1999) 'What is river health?' *Freshwater Biology*. **41**:197-209.

APPENDIX 1

AUTUMN SURVEY MARCH 2005 - SITE PHOTOGRAPHS



Huon River upstream of the Arve Road bridge.



Huon River downstream of the Southwood development site.



Kings Creek upstream of the Huon River confluence.

APPENDIX 2 SPRING SURVEY OCTOBER 2004 HABITAT ASSESSMENT

1. Conditions	Huon us Arve River	Huon ds Southwood	Kings Creek
Date	13-Oct-04	13-Oct-04	13-Oct-04
Time	16:30	11:00	12:00
Personnel	MJ, AU	MJ, AU	MJ, AU
Picker	AU	AU	MJ
Habitat	AU	AU	MJ
Site Name	Huon us Arve River bridge	Huon ds Southwood devt	Kings ck us Huon confluence
Weather	Windy, cool	Windy, mild, light drizzle	O'cast, windy, rain periods
Cloud Cover (%)	40	95	99
Air Temp (°C)	14	18	16
Rain in last week	Yes	Yes	Yes
Sampling conditions	Good	Good	Average
Picking conditions	Good	Good	Average
2. Habitat Assessment			
<i>A) Riffle or Run</i>			
Collected by	AU	AU	MJ
Picked by	AU	AU	MJ
Time taken	40 min	50 min	60 min
<i>Substrate composition</i>			
Bedrock %	0	0	0
Boulder %	5	5	0
Cobble %	40	40	5
Pebble%	40	30	35
Gravel %	10	20	40
Sand %	5	5	5
Silt %	0	0	5
Clay %	0	0	10
% Total (=100%)	100	100	100
<i>Percentage Cover</i>			
Algae %	10	20	0
Detritus %	5	0	15
Silt %	0	0	10
Moss%	0	0	0
% Total (>=<100%)	15	20	25
Mean depth (cm)	30	40	15
Residue Preserved ?	no	no	no
Comment/Photo	yes	yes	yes
3. Site Assessment			
<i>A) Vegetation (100m reach)</i>			
<i>1 = Nil (<5%)</i>			
<i>2 = Sparse (6 - 25%)</i>			
<i>3 = Moderate (26 -50%)</i>			
<i>4 = Thick (51 - 75%)</i>			
<i>5 = Extensive (>76%)</i>			
<i>These scores relate to the two rows directly below</i>			
Overhanging Vegetation	1	1	4
Trailing Bank Vegetation	3	3	4

<i>Riparian Vegetation</i>			
1 = Nil			
2 = Sparse			
3 = Moderate			
4 = Thick			
<i>These scores relate to the two rows directly below</i>			
Riparian Vegetation left	3	3	4
Riparian Vegetation right	3	3	4
<i>Composition of Riparian Vegetation</i>			
Native (%)	100	100	100
Exotic (%)	0	0	0
Total (=100%)	100	100	100
<i>Exotic Species (enter "yes" if present)</i>			
Blackberries			
Pines			
Bracken Fern			
Gorse			
Willow			
Other (please state species)			
<i>Width of Riparian Zone</i>			
1 = >40m			
2 = 30m - <40m			
3 = 20m - <30m			
4 = 10m - <20m			
5 = 5m - <10m			
6 = <5m			
<i>These scores relate to the two rows directly below</i>			
Left	1	1	1
Right	1	1	1
<i>Land Use</i>			
1 = Native forest			
2 = Forestry			
3 = Native Pasture			
4 = Grazing			
5 = Cropped			
6 = Urban			
<i>These scores relate to the two rows directly below</i>			
Left	1	1	1
Right	1	1	1
<i>Erosion</i>			
0 = None			
1 = Some			
2 = Moderate			
3 = Heavy			
<i>These scores relate to the row directly below</i>			
Evidence of Erosion	1	1	2
<i>Dams/Weirs</i>			
0 = None			
1 = Upstream			
2 = Downstream			
<i>These scores relate to the row directly below</i>			
Location of Dams/Weirs	0	0	0
<i>Pollution</i>			
0 = No evidence			
1 = Potential			
2 = Obvious			
<i>These scores relate to the row directly below</i>			
Evidence of Pollution	0	0	1

<i>Habitat Diversity part A</i>			
Riffle area (%)	40	65	20
Run area (%)	60	35	40
Pool (%)	0	0	40
Total (=100%)	100	100	100
0 = None 0%			
1 = Few <10%			
2 = Moderate 11 - 30%			
3 = Numerous 31 - 50%			
4 = Abundant >50%			
<i>These scores relate to the row directly below</i>			
Amount of Woody Debris	1	1	3
<i>Aquatic Plants</i>			
0 = None			
1 = Low			
2 = Medium			
3 = High			
<i>These scores relate to the three rows directly below</i>			
Emergent	0	0	0
Submerged	0	0	0
Floating	0	0	0
Cover over 100m (%)	0	0	0
<i>Disturbance</i>			
1 = Extreme			
2 = V.High			
3 = High			
4 = Moderate			
5 = Low			
6 = Very Low			
<i>These scores relate to the row directly below</i>			
Extent of Disturbance	5	6	5
4. Physical Parameters			
Temperature	12.2	12.0	10.4
Conductivity	84.4	82.6	134.1
pH	7.63	7.61	7.29
Dissolved O ₂	10.27	11.21	10.65
Turbidity	2.11	1.69	14.3
Guage Height (if present)	low	low	low
<i>Dams/Weirs</i>			
Distance (up/down & km)			
Discharge (m ³ /sec)			
<i>Discharge Type</i>			
P = Power Station			
R = Riparian			
S = Spill			
N = None			
<i>These scores relate to the row directly below</i>			
Discharge Type			
<i>Geographical Site Location</i>			
Eastings	485095	485264	483943
Northings	5232627	5233466	5232958
Elevation (m)	60	48	65

5. Habitat Assessment			
1. Bottom substrate / Available Cover			
Excellent (16-20)	18	19	
Good (11-15)			
Fair (6-10)			8
Poor (0-5)			
2. Embeddedness			
Excellent (16-20)	18	17	
Good (11-15)			
Fair (6-10)			8
Poor (0-5)			
3. Velocity / Depth category			
Excellent (16-20)			
Good (11-15)	14	12	15
Fair (6-10)			
Poor (0-5)			
4. Channel Alteration			
Excellent (12-15)		12	
Good (8-11)	11		
Fair (4-7)			5
Poor (0-3)			
5. Bottom Scouring & Deposition			
Excellent (12-15)		12	
Good (8-11)	11		
Fair (4-7)			5
Poor (0-3)			
6. Pool / Riffle, Run / Bend Ratio			
Excellent (12-15)			
Good (8-11)	9		
Fair (4-7)		7	7
Poor (0-3)			
7. Bank Stability			
Excellent (9-10)			
Good (6-8)	8	8	7
Fair (3-5)			
Poor (0-2)			
8. Bank Vegetative Stability			
Excellent (9-10)	9	9	
Good (6-8)			8
Fair (3-5)			
Poor (0-2)			
9. Streamside Cover			
Excellent (9-10)	10	10	10
Good (6-8)			
Fair (3-5)			
Poor (0-2)			
Column Totals			
Excellent	55	79	10
Good	53	20	30
Fair	0	7	33
Poor	0	0	0
Overall Score	108	106	73

APPENDIX 3 AUTUMN SURVEY MARCH 2005 HABITAT ASSESSMENT

1. Conditions	Huon us Arve River	Huon ds Southwood	Kings Creek
Date	9-Mar-05	9-Mar-05	9-Mar-05
Time	15:20	11:20	13:55
Personnel	MJ, AM	MJ, AM	MJ, AM
Picker	AM	AM	MJ
Habitat	MJ	MJ	AM
Location code			
Site Name	Huon us Arve River bridge	Huon ds Southwood devt	Kings ck us Huon confluence
Weather	O'cast, cool	O'cast, cool	O'cast, cool
Cloud Cover (%)	100	95	100
Air Temp (°C)	15	15	12
Rain in last week	Yes	Yes	Yes
Sampling conditions	Good	Good	Average
Picking conditions	Good	Good	Average
2. Habitat Assessment			
<i>A) Riffle or Run</i>			
Collected by	MJ	AM	MJ
Picked by	AM	AM	MJ
Time taken	40 min	40 min	60 min
<i>Substrate composition</i>			
Bedrock %			
Boulder %			
Cobble %	80	70	10
Pebble%	10	20	50
Gravel %	5	5	30
Sand %	5	5	5
Silt %			5
Clay %			
% Total (=100%)	100	100	100
<i>Percentage Cover</i>			
Algae %	20	40	5
Detritus %	20	10	40
Silt %			20
Moss%	5	20	0
% Total (>=<100%)	45	70	65
Mean depth (cm)	30	60	5
Residue Preserved ?	no	no	no
Comment/Photo	yes	yes	yes
3. Site Assessment			
<i>A) Vegetation (100m reach)</i>			
<i>1 = Nil (<5%)</i>			
<i>2 = Sparse (6 - 25%)</i>			
<i>3 = Moderate (26 -50%)</i>			
<i>4 = Thick (51 - 75%)</i>			
<i>5 = Extensive (>76%)</i>			
<i>These scores relate to the two rows directly below</i>			
Overhanging Vegetation	0	0	5
Trailing Bank Vegetation	3	4	2

<i>Riparian Vegetation</i>			
1 = Nil			
2 = Sparse			
3 = Moderate			
4 = Thick			
<i>These scores relate to the two rows directly below</i>			
Riparian Vegetation left	3	3	4
Riparian Vegetation right	3	3	4
<i>Composition of Riparian Vegetation</i>			
Native (%)	100	100	100
Exotic (%)	0	0	0
Total (=100%)	100	100	100
<i>Exotic Species (enter "yes" if present)</i>			
Blackberries			
Pines			
Bracken Fern			
Gorse			
Willow			
Other (please state species)			
<i>Width of Riparian Zone</i>			
1 = >40m			
2 = 30m - <40m			
3 = 20m - <30m			
4 = 10m - <20m			
5 = 5m - <10m			
6 = <5m			
<i>These scores relate to the two rows directly below</i>			
Left	1	1	1
Right	1	1	1
<i>Land Use</i>			
1 = Native forest			
2 = Forestry			
3 = Native Pasture			
4 = Grazing			
5 = Cropped			
6 = Urban			
<i>These scores relate to the two rows directly below</i>			
Left	1	1	1
Right	1	1	1
<i>Erosion</i>			
0 = None			
1 = Some			
2 = Moderate			
3 = Heavy			
<i>These scores relate to the row directly below</i>			
Evidence of Erosion	0	0	1
<i>Dams/Weirs</i>			
0 = None			
1 = Upstream			
2 = Downstream			
<i>These scores relate to the row directly below</i>			
Location of Dams/Weirs	0	0	0
<i>Pollution</i>			
0 = No evidence			
1 = Potential			
2 = Obvious			
<i>These scores relate to the row directly below</i>			
Evidence of Pollution	0	0	0

<i>Habitat Diversity part A</i>			
Riffle area (%)	40	10	20
Run area (%)	60	90	20
Pool (%)			60
Total (=100%)	100	100	100
0 = None 0%			
1 = Few <10%			
2 = Moderate 11 - 30%			
3 = Numerous 31 - 50%			
4 = Abundant >50%			
<i>These scores relate to the row directly below</i>			
Amount of Woody Debris	1	1	3
<i>Aquatic Plants</i>			
0 = None			
1 = Low			
2 = Medium			
3 = High			
<i>These scores relate to the three rows directly below</i>			
Emergent	0	0	0
Submerged	0	0	0
Floating	0	0	0
Cover over 100m (%)	0	0	0
<i>Disturbance</i>			
1 = Extreme			
2 = V.High			
3 = High			
4 = Moderate			
5 = Low			
6 = Very Low			
<i>These scores relate to the row directly below</i>			
Extent of Disturbance	6	6	5
4. Physical Parameters			
Temperature	11.3	10.9	12.0
Conductivity	138.0	136.2	260.0
pH	7.61	7.24	7.75
Dissolved O ₂	11.5	11.0	10.3
Turbidity	2.66	2.45	1.26
Alkalinity (mg CaCO ₃ /L)	NA	NA	NA
Gauge Height (if present)	Moderate	Moderate	Very Low
<i>Dams/Weirs</i>			
Distance (up/down & km)			
Discharge (m ³ /sec)			
<i>Discharge Type</i>			
P = Power Station			
R = Riparian			
S = Spill			
N = None			
<i>These scores relate to the row directly below</i>			
Discharge Type			
<i>Geographical Site Location</i>			
Map Reference # (1:25000)			
Eastings	485095	485264	483943
Northings	5232627	5233466	5232958
Elevation (m)	60	48	65

5. Habitat Assessment			
1. Bottom substrate / Available Cover			
Excellent (16-20)	19	18	17
Good (11-15)			
Fair (6-10)			
Poor (0-5)			
2. Embeddedness			
Excellent (16-20)	19	17	
Good (11-15)			
Fair (6-10)			10
Poor (0-5)			
3. Velocity / Depth category			
Excellent (16-20)			
Good (11-15)	11		15
Fair (6-10)		7	
Poor (0-5)			
4. Channel Alteration			
Excellent (12-15)	12	12	
Good (8-11)			8
Fair (4-7)			
Poor (0-3)			
5. Bottom Scouring & Deposition			
Excellent (12-15)	13	12	
Good (8-11)			8
Fair (4-7)			
Poor (0-3)			
6. Pool / Riffle, Run / Bend Ratio			
Excellent (12-15)			12
Good (8-11)			
Fair (4-7)	7	4	
Poor (0-3)			
7. Bank Stability			
Excellent (9-10)	9	9	
Good (6-8)			6
Fair (3-5)			
Poor (0-2)			
8. Bank Vegetative Stability			
Excellent (9-10)	10	10	
Good (6-8)			6
Fair (3-5)			
Poor (0-2)			
9. Streamside Cover			
Excellent (9-10)	10	9	
Good (6-8)			6
Fair (3-5)			
Poor (0-2)			
Column Totals			
Excellent	92	86	29
Good	11	0	49
Fair	7	11	10
Poor	0	0	0
Overall Score	110	97	88

APPENDIX 4 PREDICTOR VARIABLES FOR SPRING, AUTUMN AND COMBINED SEASON AUSRIVAS RIFFLE MODELS FOR THE 2004 - 2005 SEASONS

Table 1 Predictor variables and input values required for the spring 2004 AUSRIVAS riffle model.

CODE	BOULDER	DEPTHCM	LATITUDE	LONGITUDE	STREAMSLOPE	STREAMWIDTH
H US	1	40	5232627	485095	0.001	75
H DS	1	30	5233466	485264	0.001	70
K Ck	0	15	5232958	483943	0.02	1.43

Table 2 Predictor variables and input values required for the autumn 2005 AUSRIVAS riffle model.

CODE	ALTITUDE	CATCH AREA	COBBLE	COND	DFS	LATI-TUDE	LONGI-TUDE	RIFF-AREA	ST-ORDER
H US	60	1564.6	4	55.0	72.5	5232627	485095	20	6
H DS	48	1693.0	5	55.2	75.1	5233466	485264	10	6
K Ck	65	6.43	1	104.0	4.5	5232958	483943	20	3

Table 3 Predictor variables and input values required for the combined season 2004/2005 AUSRIVAS riffle model.

CODE	ALTITUDE	DFS	LONGITUDE	PEBBLE	STORDER	STREAMSLOPE	STREAMWIDTH
H US	60	72.5	485095	3	6	0.001	50
H DS	48	75.1	485264	2	6	0.001	71
K Ck	65	4.5	483943	2	3	0.02	1.2

CODE

H US– Huon River US of Arve River
 H DS – Huon River DS of Southwood
 K Ck – Kings Creek US Huon River

Predictor variable key and specified units:

ALTITUDE – Altitude in meters above sea level

BOULDER – Boulder value from habitat sheets (not as % but as corresponding category)

CATCHAREA – Catchment area in square kilometers

COBBLE – Cobble value from habitat sheets (not as % but as corresponding category)

CODE – Site code

COND – Water conductivity (ms/cm)

DEPTHCM – Average water depth at sample site (cm)

DFS – Distance from source of sample site (km) measured from the point of sampling along the drainage line to the furthest point upstream

LATITUDE – Easting

LONGITUDE – Northing

PEBBLE – Pebble value from habitat sheets (not as % but as corresponding category)

RIFFAREA - % Riffle area of site over 100m reach

STORDER – Strahler stream order (headwater streams start at 1), the joining of two headwater or first-order streams forms a second order stream; the junction of two second order streams forms a third order stream.

STREAMSLOPE – The distance in elevation measured as rise over run (m/m)

STREAMWIDTH – Average stream width over 100m reach (m)

APPENDIX 5 BANDING FOR AUSRIVAS O/E SCORES

Table 1. Banding for AUSRIVAS O/E scores for the spring riffle model for Tasmania.

O/E Score	Band	Inferred Condition of Macroinvertebrate Community
> 1.15	X	More diverse than reference
0.85 – 1.15	A	Similar to reference
0.56 – 0.84	B	Significantly impaired
0.27 – 0.55	C	Severely impaired
< 0.27	D	Extremely impaired

Table 2. Banding for AUSRIVAS O/E scores for the autumn riffle model for Tasmania.

O/E Score	Band	Inferred Condition of Macroinvertebrate Community
> 1.14	X	More diverse than reference
0.85 – 1.14	A	Similar to reference
0.57 – 0.84	B	Significantly impaired
0.29 – 0.56	C	Severely impaired
< 0.29	D	Extremely impaired

Table 3. Banding for AUSRIVAS O/E scores for the combined riffle model for Tasmania.

O/E Score	Band	Inferred Condition of Macroinvertebrate Community
> 1.13	X	More diverse than reference
0.87 – 1.13	A	Similar to reference
0.62 – 0.86	B	Significantly impaired
0.37 – 0.61	C	Severely impaired
< 0.37	D	Extremely impaired

Table 4. Possible banding scheme for O/E SIGNAL scores. Taken from Barmuta *et al.* 1998.

O/E Signal Score	Band	Inferred Condition of Macroinvertebrate Community
> 1.05	A1	Similar to reference (above average)
0.85 – 0.95	A2	Similar to reference (below average)
0.65 – 0.75	B	Mildly impaired
0.45 – 0.55	C	Moderately impaired
0.25 – 0.35	D	Severely impaired
< 0.15	E	Grossly impaired