

Upper Hunter

RIVER REHABILITATION INITIATIVE

Summary of Planting and Monitoring
25 August 2004 – 19 May 2005

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Summary

1. One of the objectives of the Upper Hunter River Rehabilitation Initiative (UHRRI) is to restore a riparian plant community along a 10-km reach of the river between Muswellbrook and Denman. One of the main ways in which this is being achieved is by planting native trees and shrubs along the river margins.
2. Planting undertaken under the auspices of UHRRI is closely monitored so that the success of various planting methods can be evaluated.
3. This report summarises plantings and associated monitoring undertaken along the UHRRI study reach between 25th August 2004 and 19th May 2005.
4. Between August 2004 and May 2005, 6635 trees and shrubs, of 13 species, were planted at four sites on the UHRRI reach. Ninety percent of the trees were planted at two sites ('Bengalla Benches' and 'White's Creek') by Department of Lands staff and private contractors. The remaining trees were planted at 'Chudyks' and 'Control Goats'.
5. An experiment to investigate the effects of dominant exotic plants ('weeds') on survival and growth of native plantings was started in April 2005 by Macquarie University PhD student, Garreth Kyle. Garreth will closely monitoring plants and environmental conditions over the next year.
6. A method of monitoring survival and growth of individual plants over time has been developed by UHRRI staff. A representative sample of plants at each site has been tagged and their location recorded with a hand-held GPS.
7. Estimated mean survival rate of monitored trees ranges from 58% for 5 month old trees at Bengalla Benches to 100% for 3 month old trees planted under willows above Keys Bridge.
8. The cost to establish living trees may be more meaningful than cost to simply plant trees or survival rate *per se*. The mean cost to the UHRRI project, per tree alive when last monitored, was \$2.80, and ranged from nil to \$9.14, depending on the source of trees and labour. However, only the latter cost reflects true commercial costs because a large portion of trees and labour have been provided to UHRRI free of charge.

Introduction

One of the objectives stated in the Upper Hunter River Rehabilitation Initiative Strategic Plan is to create a riparian plant community through revegetation along a 10 km stretch of the Hunter River. Revegetation efforts also contribute to two additional objectives identified in the plan: 1) increasing our understanding of how rehabilitation efforts influence, and are influenced by, the existing ecosystem, and 2) providing opportunities for UHRRI sponsors and for community involvement.

This report summarises plantings and associated monitoring undertaken along the UHRRI study reach (Figure 1) between 25th August 2004 and 19th May 2005.

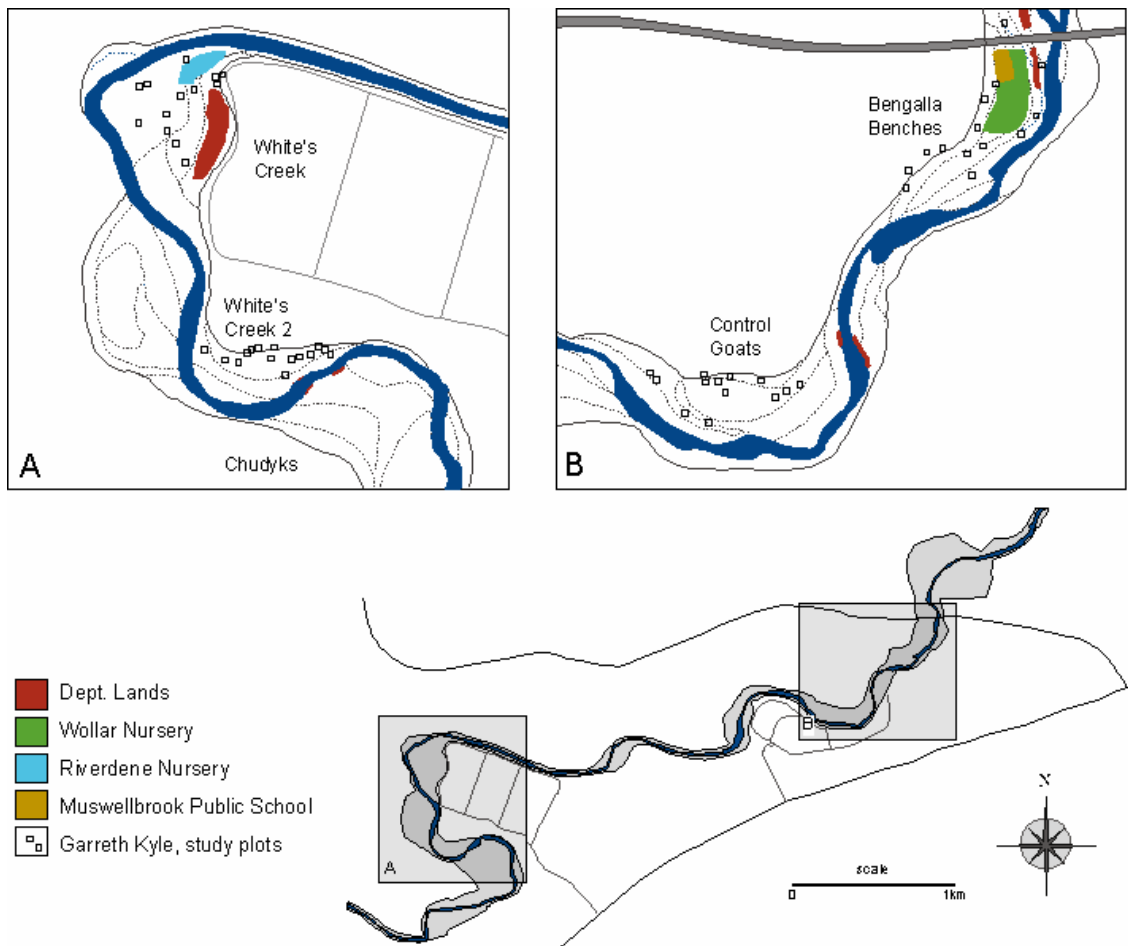


Figure 1. Location of plantings undertaken 25 August 2004 to 19 May 2005.

Plantings, August 2004 – May 2005

Between August 2004 and May 2005, 6635 trees and shrubs, of 13 species, were planted at four sites on the UHRRI reach (Table 1). Ninety percent of the trees were planted at two sites ('Bengalla Benches' and 'White's Creek') by Department of Lands staff and private contractors. The remaining trees were planted at 'Chudyks' and 'Control Goats' by the Department of Lands Scone river crew. These two sites provided an opportunity to plant native trees to replace willows that were removed during the construction and installation of large woody debris. Full details of plantings, by site, species, planting team, and date is provided in Appendix 1.

Table 1. Summary of numbers of the thirteen tree species planted along the UHRRI study reach between 25 August 2004 and 19 May 2005.

Common Name	Site				Total
	Bengalla Benches	Control Goats	White's Creek	Chudyks	
Cooba (<i>Acacia salicina</i>)			200		200
Fern-leaved wattle	40		240		280
Forest Red Gum	45		255		300
Pink tipped bottlebrush	227	20	265	65	577
River Oak	617	70	500	113	1300
River Red Gum	770	200	890	85	1945
Rough-barked Apple	205		45		250
Various ^a	320		160		480
Yellow Box			165		165
Tree Violet			40		40
White Cedar			40		40
Creek Tea Tree	313	14	265	66	658
Silver-stemmed wattle	80		280		360
Blackwood	40				40
Grand Total	2657	304	3345	329	6635

^a Mainly river oak, river red gum, creek tea tree, and pink tipped bottlebrush.

Observations of the 2003 plantings clearly indicated that there was a large degree of spatial variability in plant survival and growth within any one site. The sites selected for planting in 2004-2005 were those identified as likely to result in the greatest survival, rather than in-filling locations that had seen poor establishment the year before. The decision to enhance vegetation densities in the more-successful locations was guided by a limited capacity to maintain tubestock after planting.

In mid-May 2005, as part of an experiment being undertaken by PhD student, Garreth Kyle, 720 *Eucalyptus camaldulensis* (river red-gum) were planted at four sites on the UHRRI reach.

Exotic plants form the dominant vegetative cover along the river. Gareth's research aims to investigate the effects of some of the more common exotics on the survival and growth rates of native tubestock. Three plots, each containing 12 standard tubestock were planted within each of fennel, Johnson grass, couch, willows and slashed Johnson grass, at four sites, making a total of 60 plots or 720 plants. A number of attributes such as height, number of leaves, and photosynthetic capacity were measured for each tree prior to planting, whilst environmental variables including temperature, soil moisture, humidity, sub-canopy light infiltration and wind-speed were recorded at each plot. Plant growth and survival, and environmental conditions within the plots, will be closely monitored over the next year.



Plate 1. Dept. Lands planting at White's Creek.



Plate 2. River red gum tubestock.



Plate 3. John Gollan (Australian Museum) planting at White's Creek 2.



Plate 4. Hare browse of a recently planted river red gum.

Monitoring

The survival and growth of individual plants is being tracked by a program of monitoring developed by UHRRRI staff. A representative sample of plants from each site has been tagged and their location recorded with a hand-held GPS. Estimated mean survival rate of monitored trees ranges from 58% for 5 month old trees at Bengalla Benches to 100% for 3 month old trees planted under willows above Keys Bridge (Table 2).

When assessing survivorship, trees are categorised as 'alive', 'dead', or 'indeterminate'. Alive is defined as definitely alive, with green leaves or stem. Trees are classified as 'dead' when they have no obvious green and are completely brittle, or are no longer present. However, we have

Table 2. Monitoring established to evaluate survival of a sample of trees planted between 25 August 2004 and 19 May 2005. See text for details of monitoring methods. Note that all tree species are pooled for this summary. Note also that a further 2850 trees were planted during this period but are not being monitored.

Date and location of plantings	Planted by	No. planted	No. plants monitored	Estimated survival (%)	Age (days)	Est. trees alive	Cost per tree alive (\$)
5-8 Oct 2004 Bengalla Benches	WOL	1120	85	58	136	650	9.14
29-30 Nov 2004 Keys bridge	DOL	80	40	100	81	80	1.00
3-11 Feb 2005 White's Creek	DOL	1265	100	85	130	1075	0.63
16 May 2005 Bengalla Benches	GK	180	180	89.5	25	161	0
17 May 2005 Control Goats	GK	180	180	87.3	25	157	0
18 May 2005 White's Ck 1	GK	180	180	79.0	25	142	0
19 May 2005 White's Ck 2	GK	180	180	69.3	25	125	0
Total or Overall Mean	-	3185	945	75.0	-	2390	2.80

Explanatory Notes

1. WOL = Wollar Nurseries; DOL = Department of Lands; GK = Garreth Kyle (Macquarie University).
2. Estimated survival. This is an estimate because status of recently-planted trees cannot be reliably distinguished. Generally, the accuracy of this estimate increases with age of trees.
3. 'Age' represents the age of trees (i.e. time since planting) when survival was last monitored.
4. 'Costs' are costs to the UHRRRI project. Wollar costs represent true commercial costs; other costs are lower because trees and/or labour were provided free or at discount rates by Department of Lands, Green Corps, HCRCMA, and Garreth Kyle. Note these are costs per tree alive when last checked, not cost to plant.

often observed regrowth of earlier, apparently dead plantings, presumably from still-living roots. Thus, even apparently dead trees may later turn out to be alive. Many trees, particularly within the first few months after planting, lose all their leaves, but recover to grow quite normally. Trees without leaves, but with supple stems (can be green if the bark is scratched), are classified as 'indeterminate'.

Because of the uncertain status of recent plantings, survivorship has usually been estimated as the mean of minimum possible survivorship (assume all indeterminate trees are dead) plus maximum possible survivorship (assume all indeterminate trees are alive). The exception was White's Creek plantings by the Department of Lands in February 2005. At this site, mean survival as estimated by the above method was 73.5%, but our field observations and experience suggested that most 'indeterminate' trees would survive; we estimated survivorship at this site as 85%. Once trees reach their first growing season after planting, we expect the accuracy of our estimates of survivorship to improve, and to continue to improve as trees get older.

We have not attempted to analyse differential survival among species because of the relatively small sample sizes and the difficulty in assessing survivorship of recent plantings. However, initial inspection of the data seems to confirm field observations that river red gums, forest red gums and casuarinas have the highest survival rates whilst creek tea trees, pink-tipped bottlebrushes, and rough-barked apples have some of the lower survival rates.

The effects of browsing by mammalian herbivores is also assessed when monitoring plantings. Some recently-planted trees have exhibited classic signs of browsing by hares – i.e. a 45 degree cut to the stem (Plate 4), often within a few centimetres of the ground – sometimes with the intact, severed seedling lying beside the stem. Close monitoring of individual trees over time should help reveal the effects of browse on survival and growth, and inform management decisions about how to deal with browsing.

Cost of Plantings

Cost of plantings may be more meaningful than survival rate *per se* because availability of funding can be a major factor in limiting restoration efforts. A 'cost per tree alive when last monitored' was calculated for planting summarised in this report by dividing total cost of any given planting operation (i.e. one planting team at one site, over a short period) by the estimated number of trees alive when last assessed in the field. Note that cost per tree alive takes into account tree mortality, and is therefore higher than cost per tree planted.

For the recent UHRRI plantings, estimated costs per tree alive were \$2.80 on average and ranged from nil to \$9.14 (Table 2). However, the costs used in this analysis were the costs to the UHRRI project. These do not reflect true costs because a large portion of trees and labour have been provided to UHRRI free of charge. The only true commercial cost in Table 2 is that of the trees planted by Wollar Nurseries at Bengalla Benches in October 2004, at \$9.14 per tree alive. A lack of comparable data makes it difficult to assess whether this is 'good value' but we suspect it is, given the drought, the relatively high survival rate of these plantings, and the high quality planting job done by this team.

Costs of future plantings will be assessed on a similar basis, taking into account all costs associated with establishing trees, such as watering, hare guards (if used), and other maintenance.

Future Revegetation

UHRRI's revegetation operations are entirely contingent upon obtaining further funding. We have recently submitted two Expressions of Interest (EOI) for funding related to revegetation: one to the Hunter-Central Rivers Catchment Management Authority (HCRCMA) for funding to undertake further revegetation along the UHRRI study reach, and one to the Environmental Trust to test and develop more cost-effective revegetation techniques. On the basis of the EOI to the HCRCMA, UHRRI has been invited to submit a detailed proposal. The outcome of the first round of the Environmental Trust EOI will be announced in August 2005.

Acknowledgements

We are grateful to the individuals and organisations who did the tree planting summarised in this report: Muswellbrook Public School, Riverdene Nurseries, Wollar Nurseries, the Department of Lands Scone river crew, the Green Corps, Garreth Kyle, John Gollan, and Sarah Mika. This work is being done as part of the Upper Hunter River Rehabilitation Initiative (UHRRI), a partnership between Macquarie University, the Hunter-Central Rivers Catchment Management Authority, and the Department of Infrastructure, Planning and Natural Resources (DIPNR). Research on revegetation and rehabilitation along the UHRRI study reach is funded by ARC-Linkage Research Grant LP0346918 and contributions from the Industry Partners to this grant: DIPNR, Macquarie Generation, Mt Arthur Coal, and Bengalla Mining Company.

Appendix 1.

UHRRI Plantings 25 August 2004 – 19 May 2005.

Date	Site	No. planted	Planted by	Species	Common Name	Type	Cost to project
25-Aug-04	Bengalla Benches	80	MPS	Various	Various	Longstem	Trees only
25-Aug-04	Bengalla Benches	80	MPS	Casuarina cunninghamiana	River Oak	Longstem	Trees only
25-Aug-04	Bengalla Benches	80	MPS	Acacia parvipinnula	Silver-stemmed wattle	Longstem	Trees only
25-Aug-04	Bengalla Benches	40	MPS	Acacia melanoxylon	Blackwood	Longstem	Trees only
13-Sep-04	White's Ck	160	JUPP	Various	Various	Longstem	Trees + labour
13-Sep-04	White's Ck	160	JUPP	Acacia filicifolia	Fern-leaved wattle	Longstem	Trees + labour
13-Sep-04	White's Ck	160	JUPP	Acacia parvipinnula	Silver-stemmed wattle	Longstem	Trees + labour
13-Sep-04	White's Ck	160	JUPP	Acacia salicina	Cooba	Longstem	Trees + labour
13-Sep-04	White's Ck	180	JUPP	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees + labour
13-Sep-04	White's Ck	320	JUPP	Casuarina cunninghamiana	River Oak	Longstem	Trees + labour
13-Sep-04	White's Ck	320	JUPP	Eucalyptus	River Red Gum	Longstem	Trees +

13-Sep-04	White's Ck	40	JUPP	camaldulensis Hymenathera dentata	Tree Violet	Longstem	labour Trees + labour
13-Sep-04	White's Ck	180	JUPP	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees + labour
13-Sep-04	White's Ck	40	JUPP	Melia azedarach	White Cedar	Longstem	Trees + labour
05-Oct-04	Bengalla Benches	160	WOL	Angophora floribunda	Rough-barked Apple	Longstem	Trees + labour
05-Oct-04	Bengalla Benches	160	WOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees + labour
05-Oct-04	Bengalla Benches	320	WOL	Casuarina cunninghamiana	River Oak	Longstem	Trees + labour
05-Oct-04	Bengalla Benches	320	WOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees + labour
05-Oct-04	Bengalla Benches	160	WOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees + labour
29-Nov-04	Bengalla Benches	50	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
29-Nov-04	Bengalla Benches	40	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
29-Nov-04	Bengalla Benches	40	DOL	Acacia filicifolia	Fern-leaved wattle	Longstem	Trees only
29-Nov-04	Bengalla Benches	240	GC	Various	Various	Longstem	Trees only
30-Nov-04	Bengalla Benches	90	DOL	Casuarina cunninghamiana	River Oak	Longstem	Trees only
01-Dec-04	Bengalla Benches	135	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
02-Dec-04	Bengalla Benches	45	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
30-Nov-04	Bengalla Benches	45	DOL	Angophora floribunda	Rough-barked Apple	Longstem	Trees only
30-Nov-04	Bengalla Benches	45	DOL	Eucalyptus tereticornis	Forest Red Gum	Longstem	Trees only
08-Dec-04	Bengalla Benches	22	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
08-Dec-04	Bengalla Benches	45	DOL	Casuarina cunninghamiana	River Oak	Longstem	Trees only
08-Dec-04	Bengalla Benches	45	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
08-Dec-04	Bengalla Benches	23	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
09-Dec-04	Bengalla Benches	45	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
09-Dec-04	Bengalla Benches	82	DOL	Casuarina cunninghamiana	River Oak	Longstem	Trees only
09-Dec-04	Bengalla Benches	40	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
09-Dec-04	Bengalla Benches	45	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
10-Dec-04	Chudyks	20	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
10-Dec-04	Chudyks	30	DOL	Casuarina cunninghamiana	River Oak	Longstem	Trees only
10-Dec-04	Chudyks	22	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
10-Dec-04	Chudyks	18	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
16-Dec-04	Chudyks	12	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
16-Dec-04	Chudyks	26	DOL	Casuarina cunninghamiana	River Oak	Longstem	Trees only
16-Dec-04	Chudyks	28	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
16-Dec-04	Chudyks	14	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
17-Dec-04	Chudyks	33	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
17-Dec-04	Chudyks	57	DOL	Casuarina	River Oak	Longstem	Trees

17-Dec-04	Chudyks	35	DOL	cunninghamiana Eucalyptus camaldulensis	River Red Gum	Longstem	only Trees
17-Dec-04	Chudyks	34	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
20-Dec-04	Control Goats	20	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
20-Dec-04	Control Goats	70	DOL	Casuarina cunninghamiana	River Oak	Longstem	Trees only
20-Dec-04	Control Goats	20	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
20-Dec-04	Control Goats	14	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
03-Feb-05	White's Ck	90	DOL	Eucalyptus tereticornis	Forest Red Gum	Longstem	NIL
03-Feb-05	White's Ck	45	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	NIL
03-Feb-05	White's Ck	40	DOL	Callistemon salignus	Pink tipped bottlebrush	Longstem	Trees only
03-Feb-05	White's Ck	180	DOL	Casuarina cunninghamiana	River Oak	Longstem	NIL
03-Feb-05	White's Ck	45	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	NIL
03-Feb-05	White's Ck	120	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	Trees only
03-Feb-05	White's Ck	45	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	NIL
03-Feb-05	White's Ck	40	DOL	Leptospermum polygalifolium	Creek Tea Tree	Longstem	Trees only
03-Feb-05	White's Ck	80	DOL	Acacia parvippinula	Silver-stemmed wattle	Longstem	Trees only
03-Feb-05	White's Ck	45	DOL	Eucalyptus melliodora	Yellow Box	Longstem	NIL
07-Feb-05	White's Ck	40	DOL	Acacia salicina	Cooba	Longstem	Trees only
07-Feb-05	White's Ck	80	DOL	Acacia filicifolia	Fern-leaved wattle	Longstem	Trees only
07-Feb-05	White's Ck	40	DOL	Eucalyptus tereticornis	Forest Red Gum	Longstem	Trees only
07-Feb-05	White's Ck	80	DOL	Eucalyptus melliodora	Yellow Box	Longstem	Trees only
10-Feb-05	White's Ck	45	DOL	Eucalyptus tereticornis	Forest Red Gum	Longstem	NIL
10-Feb-05	White's Ck	45	DOL	Eucalyptus camaldulensis	River Red Gum	Longstem	NIL
10-Feb-05	White's Ck	45	DOL	Angophora floribunda	Rough-barked Apple	Longstem	NIL
11-Feb-05	White's Ck	80	DOL	Eucalyptus tereticornis	Forest Red Gum	Longstem	Trees only
11-Feb-05	White's Ck	40	DOL	Acacia parvippinula	Silver-stemmed wattle	Longstem	Trees only
11-Feb-05	White's Ck	40	DOL	Eucalyptus melliodora	Yellow Box	Longstem	Trees only
16-May-05	Bengalla Benches	180	GK	Eucalyptus camaldulensis	River Red Gum	Standard	Part labour
17-May-05	Control Goats	180	GK	Eucalyptus camaldulensis	River Red Gum	Standard	Part labour
18-May-05	White's Ck	180	GK	Eucalyptus camaldulensis	River Red Gum	Standard	Part labour
19-May-05	White's Ck	180	GK	Eucalyptus camaldulensis	River Red Gum	Standard	Part labour
Total		6635					

MPS = Muswellbrook Public School

WOL = Wollar Nurseries

JU PP = Riverdene Nurseries

GK = Garreth Kyle