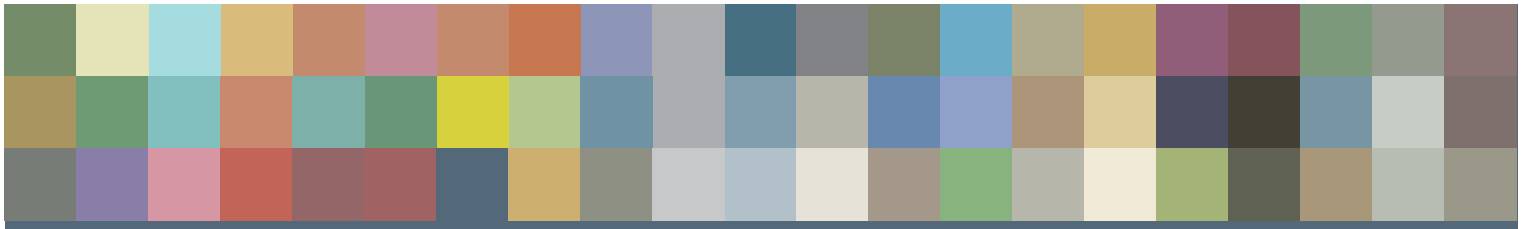

Land use summary 1999–2009

for the Mackay–Whitsunday NRM region

Department of Science, Information Technology, Innovation and the Arts
Department of Natural Resources and Mines

Queensland Government

Prepared by: Remote Sensing Centre, Science Delivery, Department of Science, IT, Innovation and the Arts

To access land use datasets we recommend using the Queensland Government Information Service(QGIS) and simply search for **land use mapping** in the type of data search, after restricting your search to **cadastral and land planning** in the topic category field. Metadata is also available from QGIS.

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Citation

DSITIA. 2012. Land use Summary 1999–2009: Mackay–Whitsunday NRM Region. Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane.

Acknowledgements

The Queensland Land Use Mapping Program (QLUMP) wishes to acknowledge the significant funding provided by the Queensland Government Reef Protection Package to compile updated land use for 2009, improved 1999 land use and 1999–2009 land use change mapping in the catchments adjacent to the Great Barrier Reef stretching from Wet Tropics in the north to the Burnett–Mary in the south.

We also wish to acknowledge the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) who coordinate the Australian Collaborative Land Use and Management Program (ACLUMP).

The QLUMP team includes staff from DSITIA in Brisbane and eight business centres of the Department of Natural Resource and Mines (NRM) throughout Queensland. The input from the regions has been extremely valuable because of their local knowledge and capacity to engage regional experts in compiling updated land use mapping.

June 2012

Table of contents

List of tables

List of figures

Introduction

The Queensland Land Use Mapping Program (QLUMP) is part of the Australian Collaborative Land Use and Management Program (ACLUMP) coordinated by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). ACLUMP promotes nationally consistent land use information.

Land use and land management practices have a profound impact on Queensland's natural resources, the environment and agricultural production. The availability of consistent and reliable spatial information on land use is critical for catchment modelling applications to monitor sediment, nutrient and water quality flows discharged to the Great Barrier Reef (GBR).

With the support of the Queensland Government Reef Protection Package, QLUMP has compiled updated land use mapping for the year 2009 in the catchments adjacent to the GBR—stretching from Wet Tropics in the north to the Burnett–Mary in the south. These include the Wet Tropics, Burdekin, Mackay–Whitsunday, Fitzroy and the Burnett–Mary Natural Resource Management (NRM) regions.

This report presents and summarises the land use mapping in the Mackay–Whitsunday NRM region (which in area accounts for 2% of the priority GBR catchments) including:

- the revised 1999 land use dataset which includes improvements and corrections to the original 1999 dataset
- the 2009 land use dataset
- the land use change dataset from 1999–2009
- summary statistics derived from the above spatial datasets
- the results of the accuracy assessment of the 2009 land use dataset

Methodology

Mapping is performed in accordance with ACLUMP guidelines. The methodology is accurate, reliable and cost-effective, and makes best use of available databases, satellite imagery and aerial photography.

The Australian Land Use and Management (ALUM) classification has a three-level hierarchical structure (Figure 1). Primary, secondary and tertiary classes are broadly structured by the potential degree of modification or impact in the landscape. The basis of the classification shows five primary classes, identified in order of increasing levels of intervention or potential impact. *Water* is included separately as a sixth primary class. The secondary level in the three-level hierarchical structure is the minimum attribution level for land use mapping in Queensland.

Primary and secondary levels relate to land use (i.e. the principal use of the land in terms of the objectives of the land manager). The tertiary level includes data on commodities or vegetation, (e.g. crops such as cereals and oil seeds). Where required[1] and possible, attribution is performed to tertiary level.

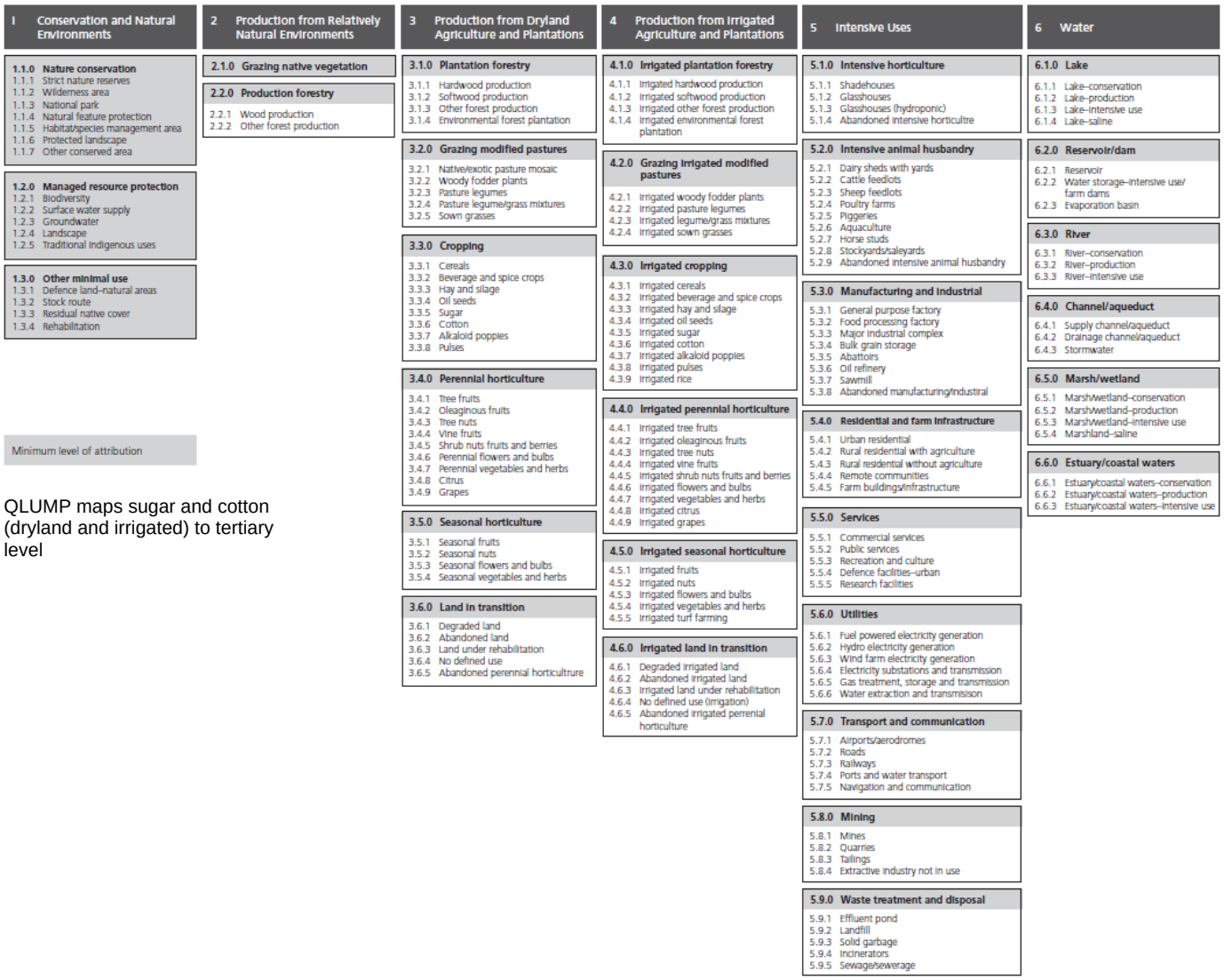
The mapping scale is 1:50 000 with a minimum mapping unit of 2 hectares and a width of 50 metres for linear features.

[1] QLUMP maps the land use classes of *sugar* and *cotton* (dryland and irrigated) to tertiary level.

The existing 1999 baseline (or later where available) land use dataset formed the basis for the 2009 land use dataset. The 1999, 2009 and 1999–2009 change datasets were then updated and improved primarily by interpretation of SPOT5 satellite imagery, high-resolution orthophotography, scanned aerial photography and inclusion of expert local knowledge. This was performed in an ESRI ArcSDE geodatabase replication environment, by overlaying the land use datasets on imagery and digitising or modifying areas previously omitted or incorrectly mapped in the 1999 mapping, as well as areas of actual land use change (2009).

Some land uses are difficult to differentiate using only satellite imagery and existing databases, for example dryland and irrigated *agriculture*. To overcome this, local expert knowledge has become an important component of the mapping methodology. This is provided by regional staff in state government agencies, natural resource management groups, shires, agricultural industries and landholders. A field survey is also undertaken to verify areas of uncertainty in the land use mapping.

The land use mapping methods used by QLUMP are described in full in the ABARES handbook: Guidelines for land use mapping in Australia: principles, procedures & definitions – Edition 4.



QLUMP maps sugar and cotton (dryland and irrigated) to tertiary level

Figure 1: Australian Land Use and Management (ALUM) classification, Version 7

Data limitations

Land uses that are linear, such as roads and railways, are not mappable at a scale of 1:50 000 with a specified minimum mapping width of 50 metres. As a result, the area estimates of these **linear features** represent only a small proportion of the actual area under this land use in Queensland. This is relevant to the following land use classes:

- *transport and communication*
- *utilities*
- *rivers.*

Similarly, land uses that fall under the QLUMP minimum mapping area of 2 hectares are not explicitly mapped but aggregated into the surrounding land use class. This will have the effect of over-estimating the area of some land use classes, for example *cropping – sugar* and *grazing native vegetation*, whereby tracks and farm infrastructure, road reserves and drainage lines are included.

The ALUM secondary classes of *grazing modified pastures* and *irrigated grazing modified pastures* have not been mapped explicitly by QLUMP, due to the difficulty in identifying and separating these classes using satellite imagery and aerial photography alone. On occasion, generally with the benefit of field verification, these classes can be mapped (e.g dairy pastures and fodder crops including leucaena).

Livestock grazing occurs on a range of pasture types including native and exotic as well as mixtures of both. Identifying and separating these using imagery, aerial photography and field observation is difficult and unreliable. Areas of pasture which appeared to be harvested for fodder or grazed off were mapped as *cropping*. This may contribute to an over-estimation of cropping in the region. Other areas mapped as *grazing native vegetation* include road reserves, cleared and uncleared land adjacent to rivers, as well as land immediately adjacent to or between cropped paddocks. *Other minimal use* may also be confused with this class. The appearance of these can be highly variable and classification may therefore not be consistent.

The distinction between (dryland) *cropping* and *irrigated cropping* was not always evident and it is likely there is some misclassification in these classes. Proximity to water sources (watercourse or dam), water entitlements (irrigation licences), field survey and local knowledge were used to confirm areas of irrigation as much as possible. Potentially areas mapped as *irrigated cropping* are only irrigated on a supplementary basis and were not actually irrigated in either 1999 or 2009.

A combination of the Queensland Herbarium's wetlands and regional ecosystem datasets provided the basis for mapping *marsh/wetlands*, *lakes*, *rivers* and *reservoir/dams*. The ephemeral nature of many of these **water features** can lead to confusion in that they may be present in imagery of one date and either absent or of differing extent in imagery of subsequent or previous dates. As a result, there are likely to be errors and omissions and some disagreement in the mapping of features such as farm dams, reservoirs, lakes, wetlands and other water features. Many water features exceed the minimum mappable area requirements, but do not meet the criteria for linear or uniform features.

The 1999 and 2009 land use datasets are both a **snapshot in time** showing what was considered the land use for each of those years. However, some effort was given to distinguishing between an actual land use change and a rotation. For example, an area that is usually cropped, but is not used for a particular purpose in the year of interest, was still mapped as *cropping* in the 2009

dataset even though no crop was present in that year. This was not considered an actual land use change, but rather a rotation, as the primary land use for that paddock would still be *cropping*.

Please refer to the metadata for details on the mapping of specific classes.

Products

1999 and 2009 land use datasets

Figure 2 and Figure 3 show the 1999 and 2009 land use datasets respectively, for the Mackay–Whitsunday NRM region, presented at the secondary level of the ALUM classification (Figure 1). Table 1 and Table 2 provide the summary statistics for each. All statistics presenting the area of land use classes are reported in hectares (ha).

Table 2 shows that *grazing native vegetation* (42%) and *irrigated cropping – sugar* (18%) are the major land use classes for 2009 in the Mackay–Whitsunday NRM region.

Analysis of the overall change between the land use classes from 1999 to 2009 shows that the largest change in area was in the *grazing native vegetation* class, which has decreased by 2% or 8167 ha. The *nature conservation* class has shown an increase of 4% or 4151 ha. There has been significant expansion of the *production from dryland agriculture and plantations* primary class, of some 23% or 1076 ha, which in further analysis shows that the majority has come from an increase in the *plantation forestry* secondary land use class of 174% or 737 ha. The *residential and farm infrastructure* secondary land use class has increased by 5% or 752 ha, due almost exclusively to the expansion of urban and rural residential classes, at the tertiary level.

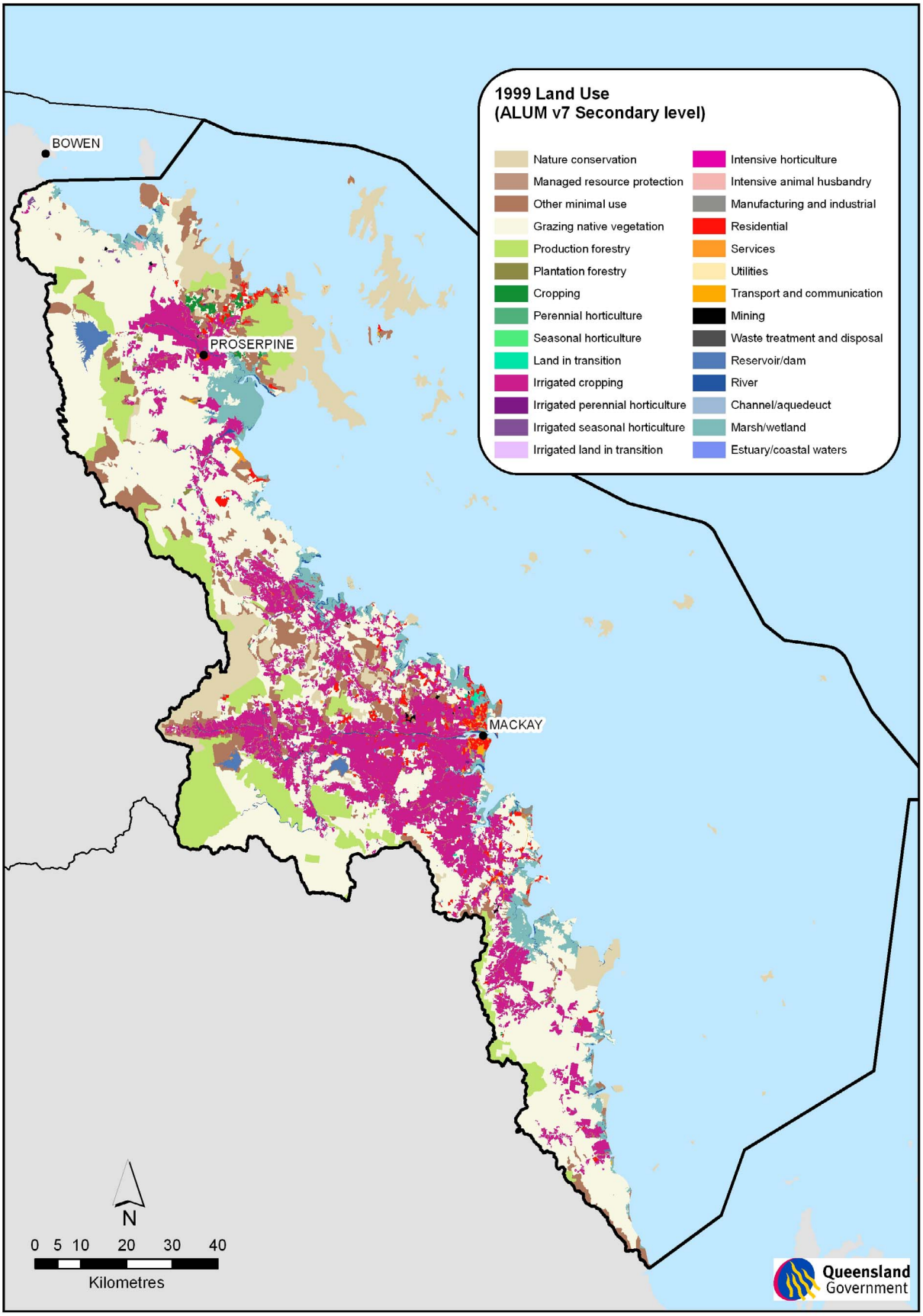


Figure 2: 1999 land use map for the Mackay–Whitsunday NRM region

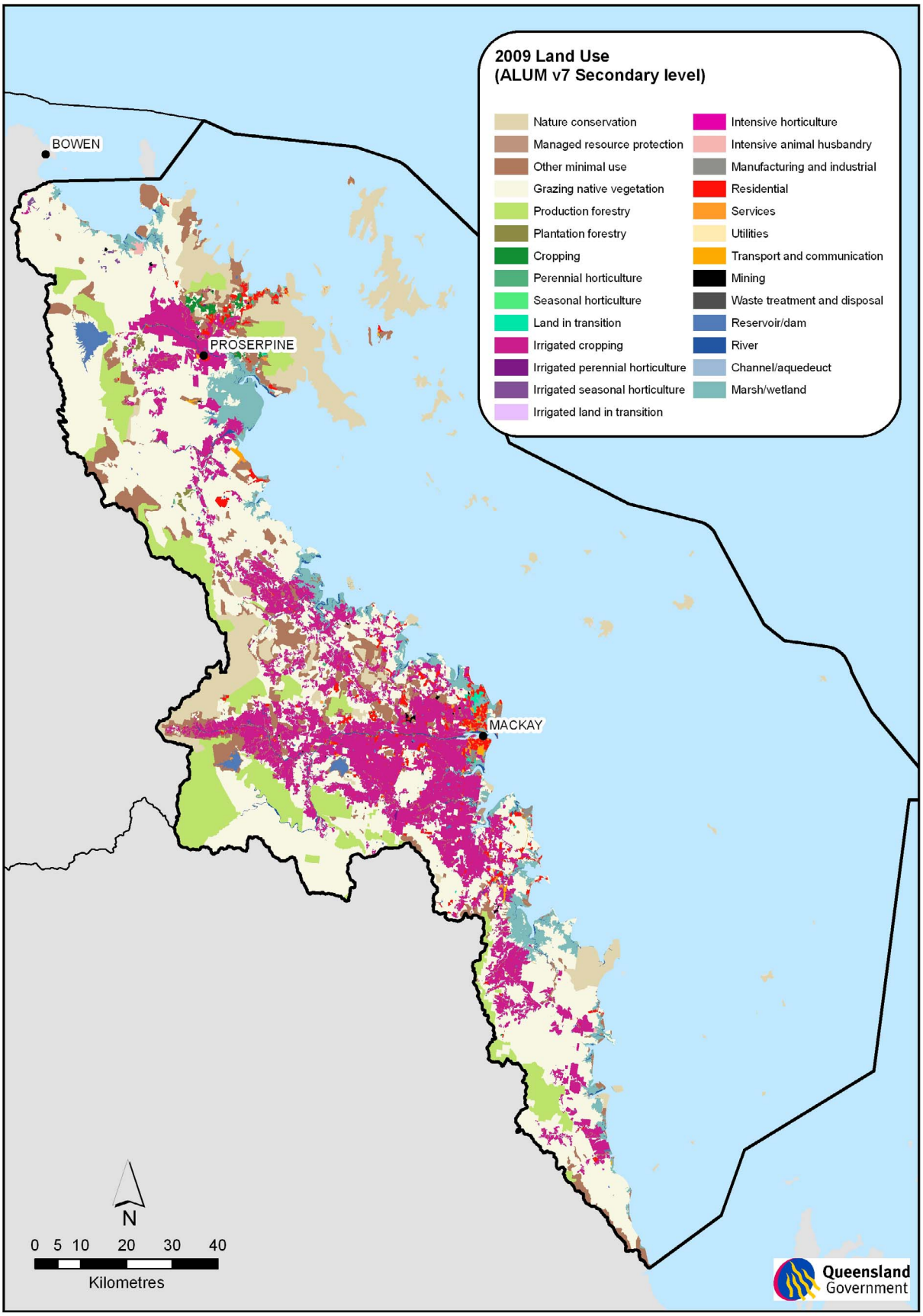


Figure 3: 2009 land use map for the Mackay–Whitsunday NRM region

Table 1: Summary statistics of land use in 1999 in the Mackay–Whitsunday NRM region

Land use code	Land use class	Area (ha)	Area %
1	Conservation and natural environments	185 279	19.76
1.1	Nature conservation	103 810	11.07
1.2	Managed resource protection	173	0.02
1.3	Other minimal use	81 296	8.67
2	Production from relatively natural environments	491 711	52.45
2.1	Grazing native vegetation	398 988	42.56
2.2	Production forestry	92 722	9.89
3	Production from dryland agriculture and plantations	4779	0.51
3.1	Plantation forestry	424	0.05
3.3	Cropping	3364	0.36
3.3.5	Cropping – sugar[1]	3315	0.35
3.4	Perennial horticulture	396	0.04
3.5	Seasonal horticulture	6	<0.01
3.6	Land in transition	588	0.06
4	Production from irrigated agriculture and plantations	165 585	17.66
4.3	Irrigated cropping	164 944	17.60
4.3.5	Irrigated cropping – sugar[1]	164 642	17.56
4.4	Irrigated perennial horticulture	210	0.02
4.5	Irrigated seasonal horticulture	416	0.04
4.6	Irrigated land in transition	16	<0.01
5	Intensive uses	21 660	2.31
5.1	Intensive horticulture	42	<0.01
5.2	Intensive animal husbandry	547	0.06
5.3	Manufacturing and industrial	1250	0.13
5.4	Residential and farm infrastructure	15 056	1.61
5.5	Services	2743	0.29
5.6	Utilities	16	<0.01
5.7	Transport and communication	1098	0.12
5.8	Mining	781	0.08
5.9	Waste treatment and disposal	125	0.01
6	Water	68 406	7.30
6.2	Reservoir/dam	7887	0.84
6.3	River	9951	1.06
6.4	Channel/aquaduct	215	0.02
6.5	Marsh/wetland	50 329	5.37
6.6	Estuary/coastal waters	25	<0.01
	Total	**937 420**	**100.00**

[1]The area of *cropping – sugar* and *irrigated cropping – sugar* are subsets of the total area of *cropping* and *irrigated cropping* respectively.

Table 2: Summary statistics of land use in 2009 in the Mackay–Whitsunday NRM region

Land use code	Land use class	Area (ha)	Area %
1	Conservation and natural environments	190 112	20.28
1.1	Nature conservation	107 961	11.52
1.2	Managed resource protection	844	0.09
1.3	Other minimal use	81 306	8.67
2	Production from relatively natural environments	484 558	51.69
2.1	Grazing native vegetation	390 821	41.69
2.2	Production forestry	93 737	10.00
3	Production from dryland agriculture and plantations	5855	0.62
3.1	Plantation forestry	1161	0.12
3.3	Cropping	3338	0.36
3.3.5	Cropping – sugar[1]	3326	0.35
3.4	Perennial horticulture	334	0.04
3.5	Seasonal horticulture	2	<0.01
3.6	Land in transition	1021	0.11
4	Production from irrigated agriculture and plantations	165 424	17.65
4.3	Irrigated cropping	164 616	17.56
4.3.5	Irrigated cropping – sugar[1]	164 393	17.54
4.4	Irrigated perennial horticulture	272	0.03
4.5	Irrigated seasonal horticulture	534	0.06
4.6	Irrigated land in transition	1	<0.01
5	Intensive uses	23 028	2.46
5.1	Intensive horticulture	46	<0.01
5.2	Intensive animal husbandry	799	0.09
5.3	Manufacturing and industrial	1421	0.15
5.4	Residential and farm infrastructure	15 808	1.69
5.5	Services	2831	0.30
5.6	Utilities	18	<0.01
5.7	Transport and communication	1201	0.13
5.8	Mining	769	0.08
5.9	Waste treatment and disposal	135	0.01
6	Water	68 444	7.30
6.2	Reservoir/dam	8367	0.89
6.3	River	9979	1.06
6.4	Channel/aquaduct	230	0.02
6.5	Marsh/wetland	49 868	5.32
	Total	**937 420**	**100.00**

[1]The area of *cropping – sugar* and *irrigated cropping – sugar* are subsets of the total area of *cropping* and *irrigated cropping* respectively.

1999–2009 land use change dataset

Figure 4, shows the 1999–2009 land use change dataset for the Mackay–Whitsunday NRM region. The data has been presented relative to the **change in intensity** of the land use at the secondary level of the ALUM classification. For example, change from 2.1.0 (*grazing native vegetation*) to 2.2.0 (*production forestry*) is an increase in land use intensity, whilst change from 2.1.0 (*grazing native vegetation*) to 1.1.7 (*nature conservation*) is a decrease. See Figure 1 for the classification, noting that as you move down and from left to right in the classification the level of intervention or potential impact on the natural landscape increases.

The total area of land use change at the secondary level from 1999–2009 is 19 393 ha. This is equivalent to 2.07% of the region. Of this 11 261 ha (58% of the total change) is mapped as an increase in land use intensity, whilst 8132 ha (42%) is a decrease.

Summary statistics presenting the land use change classes at the secondary level are shown in Table 3. The largest land use change was from *grazing native vegetation* to *production forestry*—5096 ha or 26% of the total change area, closely followed by the change in *production forestry* to *nature conservation*—4129 ha (21%). These changes can be attributed to the extensive Statewide Forests Process, as state forests in the Mackay–Proserpine region have been progressively added to the protected area estates.

Interestingly, some 2607 ha changed from *grazing native vegetation* to *irrigated cropping – sugar*, whilst the inverse, some 1651 ha changed from *irrigated cropping – sugar* to *grazing native vegetation*.

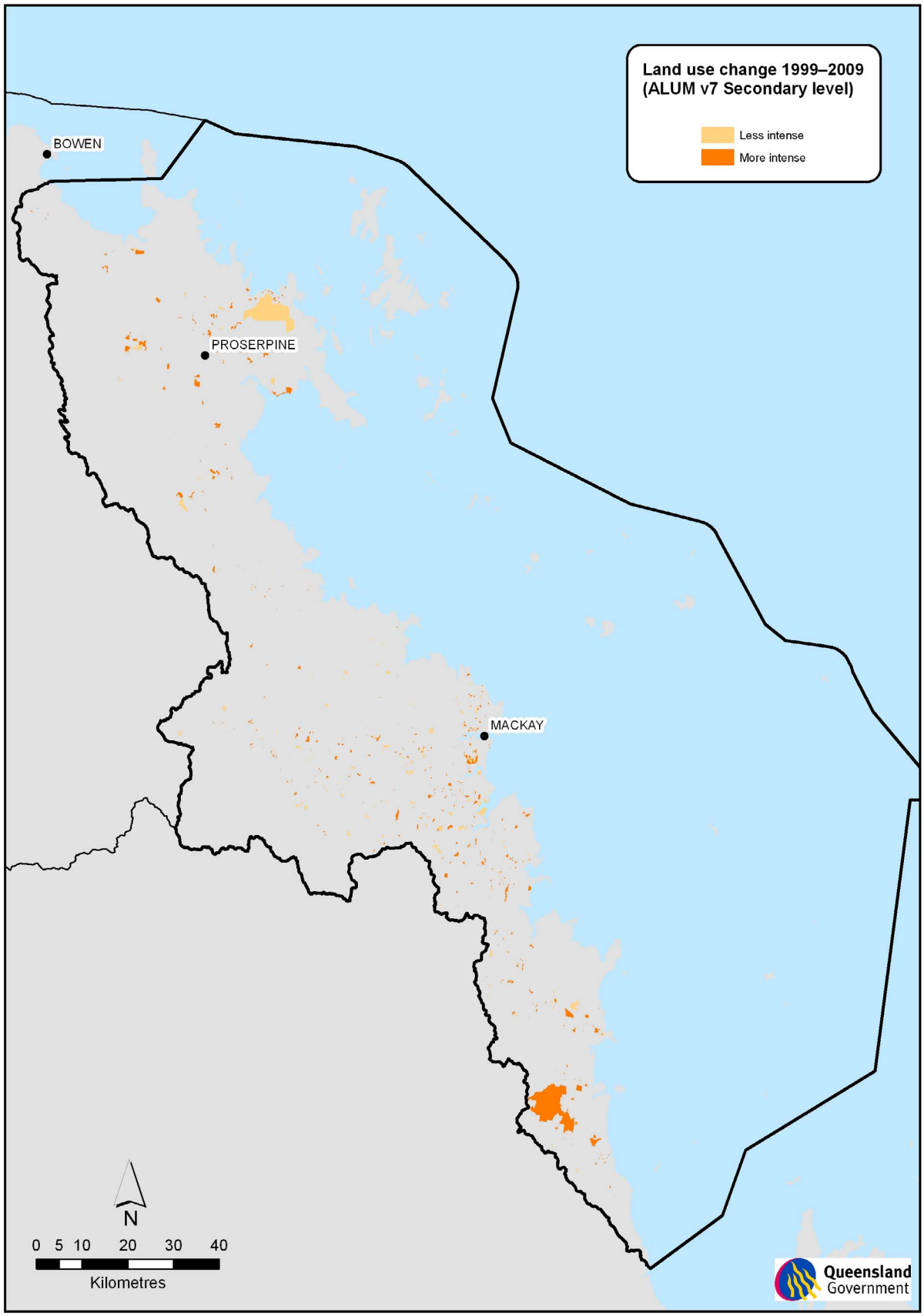


Figure 4: 1999–2009 land use change map at secondary level for the Mackay–Whitsunday NRM region

Table 3: Summary statistics for land use change at secondary level for 1999–2009 in the Mackay–Whitsunday NRM region (showing only the land use changes >25 ha)

Land use code 1999	Land use class 1999	Land use code 2009	Land use class 2009	Area (ha)	Area (%)	Total change (%)
2.1.0	Grazing native vegetation	2.2.0	Production forestry	5096	0.54	26.28
2.2.0	Production forestry	1.1.0	Nature conservation	4129	0.44	21.29
2.1.0	Grazing native vegetation	4.3.5	Irrigated cropping - sugar	2607	0.28	13.44
3.3.5	Irrigated cropping - sugar	2.1.0	Grazing native vegetation	1651	0.18	8.51
2.1.0	Grazing native vegetation	5.4.0	Residential & farm infrastructure	456	0.05	2.35
6.5.0	Marsh/wetland	1.2.0	Managed resource protection	446	0.05	2.30
2.1.0	Grazing native vegetation	1.3.0	Other minimal use	394	0.04	2.03
2.1.0	Grazing native vegetation	3.1.0	Plantation forestry	370	0.04	1.91
4.3.5	Irrigated cropping - sugar	3.1.0	Plantation forestry	367	0.04	1.89
1.3.0	Other minimal use	1.1.0	Nature conservation	309	0.03	1.59
1.1.0	Nature conservation	1.3.0	Other minimal use	288	0.03	1.49
2.1.0	Grazing native vegetation	5.2.0	Intensive animal husbandry	261	0.03	1.34
2.1.0	Grazing native vegetation	6.2.0	Reservoir/dam	260	0.03	1.34
4.3.5	Irrigated cropping - sugar	5.4.0	Residential & farm infrastructure	223	0.02	1.15
4.3.5	Irrigated cropping - sugar	6.2.0	Reservoir/dam	204	0.02	1.05
4.3.5	Irrigated cropping - sugar	3.6.0	Land in transition	170	0.02	0.88
2.1.0	Grazing native vegetation	1.2.0	Managed resource protection	127	0.01	0.66
4.3.5	Irrigated cropping - sugar	1.3.0	Other minimal use	121	0.01	0.62
4.3.5	Irrigated cropping - sugar	5.3.0	Manufacturing and industrial	111	0.01	0.57
2.1.0	Grazing native vegetation	3.6.0	Land in transition	110	0.01	0.57
4.3.5	Irrigated cropping - sugar	4.4.0	Irrigated perennial horticulture	99	0.01	0.51
1.3.0	Other minimal use	5.4.0	Residential & farm infrastructure	90	0.01	0.46
1.3.0	Other minimal use	4.3.5	Irrigated cropping - sugar	89	0.01	0.46
4.3.5	Irrigated cropping - sugar	5.7.0	Transport and communication	85	0.01	0.44
1.3.0	Other minimal use	2.1.0	Grazing native vegetation	81	0.01	0.42
1.3.0	Other minimal use	3.6.0	Land in transition	80	0.01	0.41
2.1.0	Grazing native vegetation	4.5.0	Irrigated seasonal horticulture	71	0.01	0.37
2.1.0	Grazing native vegetation	1.1.0	Nature conservation	59	0.01	0.30
3.4.0	Perennial horticulture	3.6.0	Land in transition	54	0.01	0.28
4.4.0	Irrigated perennial horticulture	4.5.0	Irrigated seasonal horticulture	50	0.01	0.26
1.1.0	Nature conservation	1.2.0	Managed resource protection	50	0.01	0.26
1.3.0	Other minimal use	1.2.0	Managed resource protection	48	0.01	0.25
1.3.0	Other minimal use	2.2.0	Production forestry	46	<0.01	0.24
3.6.0	Land in transition	4.3.5	Irrigated cropping - sugar	37	<0.01	0.19
1.3.0	Other minimal use	5.3.0	Manufacturing and industrial	33	<0.01	0.17
4.3.5	Irrigated cropping - sugar	5.9.0	Waste treatment and disposal	31	<0.01	0.16
2.1.0	Grazing native vegetation	5.3.0	Manufacturing and industrial	29	<0.01	0.15
1.3.0	Other minimal use	5.5.0	Services	29	<0.01	0.15
1.3.0	Other minimal use	6.3.0	River	28	<0.01	0.14
Total				**19 393**	**2.07**	**100**

Data format and availability

To access land use datasets we recommend using the Queensland Government Information Service (QGIS) and simply search for **land use mapping** in the type of data search, after restricting your search to **cadastral and land planning** in the topic category field. Metadata is also available from QGIS.

The dataset comprises an ESRI vector geodatabase at a nominal scale of 1:50 000. The feature classes are each a polygon dataset with each class having attributes describing land use. Land use is classified according to the Australian Land Use and Management Classification (ALUMC) Version 7, May 2010. Note that a representation showing land use at the secondary level is available when working within a geodatabase.

Digital data are supplied with a licence and by using the data you confirm that you have read the licence conditions included with the data and that you agree to be bound by its terms.

Appendix A Accuracy assessment

The accuracy assessment provided reference data suitable for assessing the 2009 land use map. For each of the sample points, the true land use class was determined (reference data) based on aerial photograph interpretation, landholder contact or expert knowledge. These points were then compared to the mapped class (map data) and the information was summarised in the error matrix. The accuracy is summarised in terms of total accuracy, Kappa and user's and producer's accuracies. Each accuracy parameter is reported using a point estimate and a 95% posterior interval. Accuracy figures are provided as probabilities between 0 and 1.

Total accuracy provides an estimate of the overall accuracy of the map, and can be expressed as the probability that a point is mapped correctly. Total accuracy can be misleading, particularly when one class dominates the others. The Kappa statistic attempts to overcome this problem by adjusting for chance agreement. A common rule of thumb suggests a value of Kappa between 0.6 and 0.8 represents moderate agreement between the map and the ground truth; a value greater than 0.8 suggests strong agreement. Values less than 0.2 suggest the map is little better than a map produced by random allocation.

The user's and producer's accuracies summarise the map's accuracy on a per-class basis. User's accuracy for class A is the probability that a point mapped as A is truly in class A. If we estimated the user's accuracy of class A to be 0.84, then from a random sample of 100 points chosen from areas on the map in this class, around 84 would be found to be correct when checked in the field. Producer's accuracy for class B is the conditional probability that the map will show a site as class B given its true state is class B. If the producer's accuracy for class B were 0.84, then from a random sample of 100 points known to be in class B around 84 would also be in class B according to the map. An accurate map should have both high user's and producer's accuracies.

Within the user and producer accuracy assessment, the per-class estimates of accuracy are often not very precise, since only part of the total sample points are used to estimate them. As a guide, if the upper bound of the interval for either user's or producer's accuracy is less than 0.5, this can indicate a true misclassification problem, rather than one due to inadequacies in sample size.

Sometimes points that differ between the map and the reference data are due to positional or spatial errors. Inaccurate registration of datasets is an example of spatial error. Thematic errors are the incorrect labelling of an area due to difficulties in determining the true land use in that area, or by oversight or other operational errors. Spatial errors influence thematic accuracy. The purpose here is to assess the thematic accuracy of land use data. However, the separation of spatial and thematic errors can be difficult and has not been undertaken. As a result, the accuracy assessment reflects properties of the land use data as a whole.

Note that the revised 1999 land use data and the 1999–2009 land use change datasets were not accuracy assessed.

2009 land use dataset

The 2009 land use dataset was accuracy assessed with 410 points based on a random sampling strategy, using the map classes (area and frequency) as the strata. The stratified estimate of total accuracy is 0.91 (0.86, 0.94) and Kappa is 0.87 (0.81, 0.91). As the lower bound of the confidence interval for total accuracy is greater than 0.8, the mapping meets ACLUMP specification.

Table 4 provides the error matrix for the accuracy assessment of the 2009 land use data. For the majority of classes, the reference data agreed with the map data. For example, *irrigated cropping – sugar* had 70 sample points identified. For 67 of those points, the map data was also *irrigated cropping – sugar* and therefore correct. For three of the points the map data was incorrect with two points falling onto the mapped class *other minimal use*, and one point in *river*.

The column 'proportion' in Table 4 is the relative proportion in area of the classes that were assessed, not of the catchment as a whole. The areas of other classes that are not amenable to assessment—for example, *nature conservation*—are removed from the total area before the proportions are calculated. This column will thus sum to 100%.

The error matrix (Table 4) shows that the land use class of *managed resouce protection* has been misclassified in the mapping as *other conserved area*, specifically relating to nature refuges. Note that this was corrected in the final mapping products. Also highlighted is the confusion in the *water* primary land use class between mapping the *rivers* and *estuary/coastal water.*

Table 5 provides the user's and producer's accuracy for the 2009 Mackay–Whitsunday NRM land use dataset. The majority of land use classes in this catchment have been mapped accurately. The largest assessable land use class in this catchment is *grazing native vegetation* which has been mapped with a very high user's and producer's accuracies of 0.920 and 0.974 respectively. The next largest class by area is *irrigated cropping – sugar* which also returned a high user's and producer's accuracy of 0.948 and 0.987. The user's accuracy suggests that some areas mapped as *irrigated cropping – sugar* were actually a different land use. The error matrix (Table 4) provides more detail on the misclassifications. However the very high producer's accuracy suggests that most areas of actual *irrigated cropping – sugar* have been captured in the map.

Accuracy estimates based on samples with fewer than two points are not considered sufficiently reliable, and are presented as NA (not available) in the table. Examples of this are *managed resource protection*.

The user's and producer's accuracy results should be interpreted individually for their respective classes—noting that the smaller classes proportionally to the overall area assessed, and also a small sample size will return a wide confidence interval. The overall accuracy shows a much tighter confidence interval as it effectively summarises the accuracy results for all the assessable classes.

Some classes with low accuracies have insufficient sample points to provide precise estimates. The producer's accuracy for *residential and farm infrastructure* is 0.962; however, from the 95% interval (0.669, 0.990) we see that more sample points would be required to confidently determine how accurate this class is. The other classes with a relatively low accuracy and very large confidence intervals constitute a small proportion (<0.2% each) of the area assessed.

Table 4: Error matrix for the Mackay–Whitsunday NRM region 2009 land use dataset

		Reference data																											
Map data	2009 land use class	Other conserved area	Managed resource protection	Other minimal use	Grazing native vegetation	Production forestry	Plantation forestry	Cropping	Cropping – sugar	Perennial horticulture	Land in transition	Irrigated cropping	Irrigated cropping – sugar	Irrigated perennial horticulture	Irrigated seasonal horticulture	Intensive horticulture	Intensive animal husbandry	Manufacturing and industrial	Residential & farm infrastructure	Services	Transport and communication	Mining	Waste treatment and disposal	Reservoir/dam	River	Channel/aquaduct	Marsh/wetland	Estuary/coastal waters	Total	Proportion (%)
	Other conserved area	**2**	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.09
	Managed resource protection	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11
	Other minimal use	0	0	**28**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	9.61
	Grazing native vegetation	0	0	4	**65**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	47.2
	Production forestry	0	0	0	0	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	11.2
	Plantation forestry	0	0	0	1	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.14
	Cropping	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	Cropping – sugar	0	0	0	0	0	0	0	**4**	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0.39
	Perennial horticulture	0	0	1	1	0	0	0	0	**2**	0	0	0	4	0	0	0	0	2	0	0	0	0	0	0	0	0	0	10	0.04
	Land in transition	0	0	0	3	0	0	0	0	0	**5**	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	10	0.12
	Irrigated cropping	0	0	0	0	0	0	2	0	0	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.03
	Irrigated cropping – sugar	0	0	2	0	0	0	0	0	0	0	0	**67**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	70	19.8
	Irrigated perennial horticulture	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.03
	Irrigated seasonal horticulture	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0.06
	Intensive horticulture	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**5**	0	0	0	2	0	0	0	0	0	0	0	0	9	0.01
	Intensive animal husbandry	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**8**	0	0	0	0	0	0	0	0	0	0	0	9	0.10
	Manufacturing and industrial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**	0	1	0	0	0	0	0	0	0	0	9	0.17
	Residential & farm infrastructure	0	0	1	4	0	0	0	0	0	0	0	0	1	0	0	0	0	**22**	0	0	0	0	0	0	0	0	0	28	1.90
	Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	10	0.34
	Transport and communications	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	0	0	0	0	0	0	10	0.14
	Mining	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**	0	0	0	0	0	0	10	0.09
	Waste treatment and disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**8**	0	0	0	0	0	9	0.02
	Reservoir/dam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**14**	0	0	1	0	15	1.01
	River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	0	0	7	10	1.20
	Channel/aquaduct	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**	0	0	10	0.03
	Marsh/wetland	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**26**	1	29	6.00
	Estuary/coastal waters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0.00
	Total	2	9	39	82	16	4	2	4	2	5	4	72	15	6	5	8	8	26	15	9	8	8	14	4	8	27	8	**410**	**100**

Table 5: User's and producer's accuracy for the Mackay–Whitsunday NRM region 2009 land use dataset

Class	User's			Producer's		
	50%	95% interval		50%	95% interval	
Other conserved area	0.165	0.026	0.438	0.318	0.014	0.977
Managed resource protection	NA	NA	NA	NA	NA	NA
Other minimal use	0.914	0.781	0.980	0.730	0.567	0.871
Grazing native vegetation	0.920	0.843	0.968	0.974	0.947	0.988
Production forestry	0.958	0.786	0.999	0.952	0.806	0.996
Plantation forestry	0.696	0.290	0.953	0.764	0.109	0.996
Cropping	NA	NA	NA	NA	NA	NA
Cropping – sugar	0.395	0.142	0.708	0.839	0.166	0.997
Perennial horticulture	0.164	0.026	0.455	0.176	0.007	0.937
Land in transition	0.455	0.195	0.733	0.643	0.073	0.992
Irrigated cropping	0.589	0.225	0.887	0.355	0.021	0.976
Irrigated cropping – sugar	0.948	0.881	0.985	0.987	0.958	0.995
Irrigated perennial horticulture	0.936	0.699	0.998	0.197	0.039	0.546
Irrigated seasonal horticulture	0.777	0.434	0.965	0.613	0.063	0.990
Intensive horticulture	0.503	0.217	0.788	0.081	0.004	0.837
Intensive animal husbandry	0.820	0.529	0.974	0.728	0.102	0.994
Manufacturing and industrial	0.825	0.531	0.972	0.820	0.159	0.997
Residential & farm infrastructure	0.764	0.593	0.890	0.962	0.669	0.990
Services	0.936	0.698	0.998	0.828	0.299	0.957
Transport and communications	0.844	0.558	0.975	0.799	0.144	0.996
Mining	0.742	0.449	0.936	0.687	0.082	0.994
Waste treatment and disposal	0.827	0.523	0.973	0.307	0.019	0.965
Reservoir/dam	0.893	0.687	0.983	0.969	0.564	1.000
River	0.259	0.069	0.551	0.526	0.133	0.937
Channel/aquaduct	0.747	0.453	0.935	0.400	0.029	0.981
Marsh/wetland	0.877	0.727	0.961	0.982	0.884	0.998
Estuary/coastal waters	NA	NA	NA	NA	NA	NA

Table 4: Error matrix for the Mackay–Whitsunday NRM region 2009 land use dataset

		Reference data																											
	2009 land use class	Other conserved area	Managed resource protection	Other minimal use	Grazing native vegetation	Production forestry	Plantation forestry	Cropping	Cropping – sugar	Perennial horticulture	Land in transition	Irrigated cropping	Irrigated cropping – sugar	Irrigated perennial horticulture	Irrigated seasonal horticulture	Intensive horticulture	Intensive animal husbandry	Manufacturing and industrial	Residential & farm infrastructure	Services	Transport and communication	Mining	Waste treatment and disposal	Reservoir/dam	River	Channel/aquaduct	Marsh/wetland	Estuary/coastal waters	Total	Proportion (%)
Map data	**Other conserved area**	**2**	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.09
	Managed resource protection	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11
	Other minimal use	0	0	**28**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	9.61
	Grazing native vegetation	0	0	4	**65**	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	47.26
	Production forestry	0	0	0	0	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	11.29
	Plantation forestry	0	0	0	1	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.14
	Cropping	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
	Cropping – sugar	0	0	0	0	0	0	0	**4**	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0.39
	Perennial horticulture	0	0	1	1	0	0	0	0	**2**	0	0	0	4	0	0	0	0	2	0	0	0	0	0	0	0	0	0	10	0.04
	Land in transition	0	0	0	3	0	0	0	0	0	**5**	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	10	0.12
	Irrigated cropping	0	0	0	0	0	0	2	0	0	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0.03
	Irrigated cropping – sugar	0	0	2	0	0	0	0	0	0	0	0	**67**	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	70	19.81
	Irrigated perennial horticulture	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.03
	Irrigated seasonal horticulture	0	0	0	0	0	0	0	0	0	0	0	0	0	**6**	0	0	0	1	0	0	0	0	0	0	0	0	0	7	0.06
	Intensive horticulture	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**5**	0	0	0	2	0	0	0	0	0	0	0	0	9	0.01
	Intensive animal husbandry	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**8**	0	0	0	0	0	0	0	0	0	0	0	9	0.10
	Manufacturing and industrial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**	0	1	0	0	0	0	0	0	0	0	9	0.17
	Residential & farm infrastructure	0	0	1	4	0	0	0	0	0	0	0	0	1	0	0	0	0	**22**	0	0	0	0	0	0	0	0	0	28	1.90
	Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	10	0.34
	Transport and communications	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	0	0	0	0	0	0	10	0.14
	Mining	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**	0	0	0	0	0	0	10	0.09
	Waste treatment and disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**8**	0	0	0	0	0	9	0.02
	Reservoir/dam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**14**	0	0	1	0	15	1.01
	River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	0	0	7	10	1.20
	Channel/aquaduct	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**8**	0	0	10	0.03
	Marsh/wetland	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**26**	1	29	6.00
	Estuary/coastal waters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0.00
	Total	2	9	39	82	16	4	2	4	2	5	4	72	15	6	5	8	8	26	15	9	8	8	14	4	8	27	8	**410**	**100**