

Detectibility of Small Manchurian Wild Rice Infestations around the Kaipara Harbour, Northland Using High Resolution Satellite Imagery from Quickbird/KiwImage

Stella Belliss, David Pairman



Landcare Research
Manaaki Whenua

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Satellite Imagery from Quickbird/KiwiImage**

Stella Belliss, David Pairman

Landcare Research
PO Box 40, Lincoln 7640
New Zealand

Landcare Research Contract Report: LC0809/119

PREPARED FOR:
Northland Regional Council
(Envirolink contract 660-NLRC91)

DATE: April 2009



ISO 14001

Reviewed by:

Approved for release by:

Stephen McNeill
Scientist
Landcare Research

Robert Gibb
Science Team Leader
Informatics

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Contents

Summary	i
1. Introduction	1
2. Background	1
3. Objectives	2
4. Methods	2
4.1 Imagery available for the study	2
4.2 Description of the test sites	3
4.3 Image processing	6
4.4 Principal component analysis	7
4.5 Object-oriented analyses	7
5. Results	7
6. Conclusion	8
7. Recommendation	8
8. Acknowledgements	8
9. References	8

Summary

Project and Client

In an Envirolink small advice project requested by Northland Regional Council, we have analysed a small sample of KiwImage data, plus some SPOT 5 imagery, in an attempt to identify Manchurian rice grass (*Zizania latifolia*).

Objectives

- Identify KiwImage data tiles in Northland that coincide with rice grass sites around the Kaipara
- Examine the data to look for ways to map this pest species
- Report the results to Northland Regional Council

Methods

- Northland Regional Council supplied us with single point coordinates of 10 small areas where Manchurian rice grass was present.
- KiwImage data for NZTM sheets AW27, AW28, AX27, AX28, and AY28 were loaded and the rice grass sites included on them were outlined and saved as ‘areas of interest’ (AOIs).
- A limited selection of SPOT-5 satellite imagery, available via the LUCAS Whole-of-Government scheme, was also loaded and processed to augment the KiwImage data.
- Imagery was examined to look for unique spectral response from the Manchurian rice grass sites.

Results

- Unfortunately, while we had expected there to be full Northland coverage by KiwImage as it is a priority area, only four of the 10 sites identified by Northland Regional Council were in fact covered by the KiwImage data at the time of analysis.
- Of the areas that we had imagery for, many were extremely small or of elongated shape making it difficult to extract reliable spectral signatures. Even with the high resolution of KiwImage (4-m multispectral and 0.7-m panchromatic) it was not adequate for the size and shape of the sites identified.
- Neither the KiwImage nor the SPOT-5 imagery showed a unique spectral response for Manchurian rice grass.

Conclusions

- Based on a dataset limited by both coverage, available spectra (in the case of KiwImage), spatial resolution (in the case of SPOT) and acquisition dates, we were unable to distinguish Manchurian rice grass from other vegetation types in Northland.
- Based on this dataset, we think it unlikely that larger areas of rice grass could be distinguished using imagery with broad spectral bands (such as SPOT and Quickbird).
- Improved spectral or textural methodologies might assist discrimination of rice grass.

Recommendations

- Identification of small outlier sites of this pest plant is still best achieved by ground-based methods, unless either airborne or high-resolution satellite hyperspectral data become available.

1. Introduction

Manchurian rice grass (*Zizania latifolia*) is a semi-aquatic pest plant that has successfully invaded extensive areas of the Kaipara region in Northland. Northland Regional Council requested information on how new satellite image data, particularly KiwiImage, could be used to identify outlier sites. The work was carried out under an Envirolink small advice grant (660-NLRC91) from the Foundation for Research, Science and Technology.

2. Background

Manchurian wild rice was introduced from Asia in ships' ballast, around 1900 (Arnold 1959). It is a perennial grass that can grow up to 3 m tall and forms dense stands on land and water margins, overtopping other species. It has established in New Zealand, especially in Northland and Auckland. MAF Biosecurity and some regional councils actively work to remove identified stands but both the seed and rhizome fragments are carried to new sites by birds, water, and contaminated machinery and germinate quickly. The sooner outlier sites can be found, the easier it is to remove and control this pest species.

Some vegetation types can be identified from multispectral satellite imagery. For this to be feasible, the vegetation type must have a spectral signature (a single or a combination of responses in one or more bandwidths) that enables it to be distinguished from other vegetation types in that area. It must also be present in the target area in clumps larger than the spatial resolution (pixel size) of the sensor in use. So, a pest species that occurs in clumps of, say, 10 × 10 m would need a satellite or airborne sensor to have a spatial resolution of under 5 m to have any chance of being identified.

Now that satellite services can provide high resolution imagery, and now that the whole-of-Government Imagery – KiwiImage – data acquisition has commenced, it was of interest to test the use of these data for identifying Manchurian rice grass stands.

Manchurian rice grass is sometimes confused with raupō (*Typha orientalis*) and flax (*Phormium* spp.); however, in winter, rice grass remains green whereas the raupō dies back (i.e. greys off). In November–December rice grass produces a large red/brown/purple flowerhead. Therefore, imagery taken either in winter or in early summer should offer the best opportunities to discriminate between the grass and other similar targets.

3. Objectives

- Identify KiwImage data tiles in Northland that coincide with rice grass sites around the Kaipara.
 - Examine the data to look for ways to map this pest species.
 - Report the results to Northland Regional Council.
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4. Methods

4.1 Imagery available for the study

KiwImage/Quickbird

KiwImage data for NZTM sheets AW27, AW28, AX27, AX28, and AY28 were loaded and the rice grass sites included on them were outlined and saved as ‘areas of interest’ (AOIs). KiwImage data are imagery from the Quickbird satellite. Details of the data used are shown in Table 1.

Table 1 Satellite image data used in the study

Image	Spatial resolution	Spectral bands	Coverage
Quickbird KiwImage tile 5757513_mul_07May07_r8c2	4 m	Blue, green red, NIR	Three test sites near Te Kopura, two very close together
Quickbird KiwImage tile 5757513_mul_07May07_r6c2	4 m	Blue, green red, NIR	One test site near Tangowahine Stream
SPOT 5 438422_080409 from LUCAS WoG dataset	10 m	Green red, NIR, SWIR	Three test sites near Te Kopura, two very close together
SPOT 5 437422_080410 from LUCAS WoG dataset	10 m	Green red, NIR, SWIR	One test site near Tangowahine Stream
SPOT 5 437422_061122 from LUCAS WoG dataset	10 m	Green red, NIR, SWIR	One test site near Tangowahine Stream

KiwImage data supply commenced 3 years ago with full New Zealand, Ross Dependency, and Southwest Pacific Island coverage to be completed by 2010. Land Information New Zealand, one of the major contributors to KiwImage funding, had a collection priority list, driven by the NZTopo50 maintenance priorities, and headed up by Northland and Auckland. When this Envirolink project commenced, only a limited selection of Northland mapsheets

were available in KiwiImage. Our assumption that this would soon be resolved since this is the priority 1 coverage area has proved incorrect and there is still no coverage of the Kaipara, Whangarei, and any of Northland above Rawene.

Of the 10 test sites provided by Northland Regional Council, KiwiImage data only covered four. Two subscenes from these data, one including the northernmost test site; the other covering the other three, were extracted and these were used for the analyses.

The KiwiImage data are derived from the Quickbird satellite instrument and where available the data come as 4-m multispectral (blue, green, red and NIR), 0.7-m panchromatic, and a 0.7-m natural colour pan-enhanced version – which is a three-band (blue, green, red) image synthesised from both the multispectral and panchromatic datasets.

SPOT-5 data

To augment the limited Quickbird/KiwiImage data, a selection of SPOT-5 satellite imagery, available via the LUCAS Whole-of-Government scheme was also loaded and processed (Table 1). These data cover the same four test sites.

4.2 Description of the test sites

Imagery was examined to look for unique spectral response from the test sites

Site 1: NZTM 1682432/6037859 NZMG 6599759/2593109 (P07) near Tangowahine Stream (which feeds into the Wairoa River north of Dargaville)

The site, which is between a small stand of bush on the edge of a small hillock, and a drain, and flanked by what appears to be some low scrub on the north and east, looks like a dam. In the Quickbird imagery, vegetation, presumably the rice grass, surrounds a small central patch of what looks like very shallow water. Shadowing associated with this suggests that this circling vegetation is higher than the surrounding land covers. Three different satellite images include this site and descriptions of what can be seen are listed below.

Quickbird/KiwiImage – 7 May 2007 (Fig. 1)

In this image, details such as individual trees, the drains and creeks, and small areas of bare ground are clearly visible. The pond area and the rice grass are seen but do not look spectrally different from the surroundings in multispectral mode. In pan-sharpened ‘natural’ colour, the rice grass appears slightly lighter than the surrounding pastures and very similar to some of the paddocks where the grass growth looked less vigorous.

Spot 5 – 22 November 2006 (Fig. 2, left)

The area looks no different than the surrounding paddocks. The small stand of bush, the scrub, and the nearby road and shelterbelt are able to be detected. At this time, the Manchurian rice grass should have been in flower, which might have given a different spectral response from the surrounds, but none can be distinguished. However, note that Arnold (1959) states that it flowers irregularly so it might be that this was an ‘off’ year. In addition, the 10-m pixels of the SPOT-5 multispectral sensor mean that the target area only fills 3–4 pixels and there may very well be edge contamination from surrounding pixels.

SPOT 5 – 10 April 2008 (Fig. 2 right)

In this image, the stand of bush and the scrub, the shelterbelt and some of the road are still detectable as discrete targets. The paddock that contains the dam is showing up as bare or near-bare ground and has probably been recently ploughed/disked. The area corresponding to the dam has the same spectral responses as the paddock, albeit with a very bright (saturated in some spectral bands) response at the south-eastern end. Could this mean that the rice grass has been removed?

Small subscenes (880 × 1060 m) from the SPOT images are shown in Fig. 2.

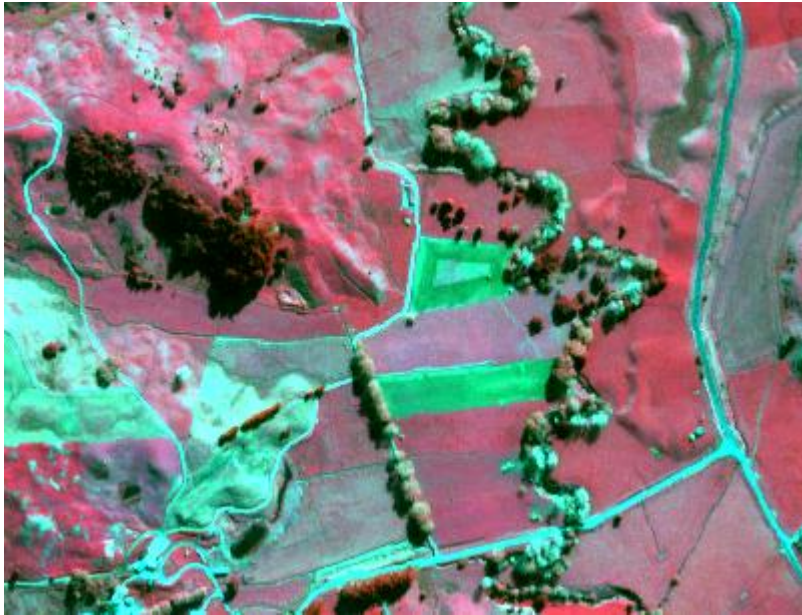


Fig. 1 Subscene of multispectral Quickbird/KiwiImage data (standard false-colour composite) showing Manchurian rice grass test site 1 centre left.

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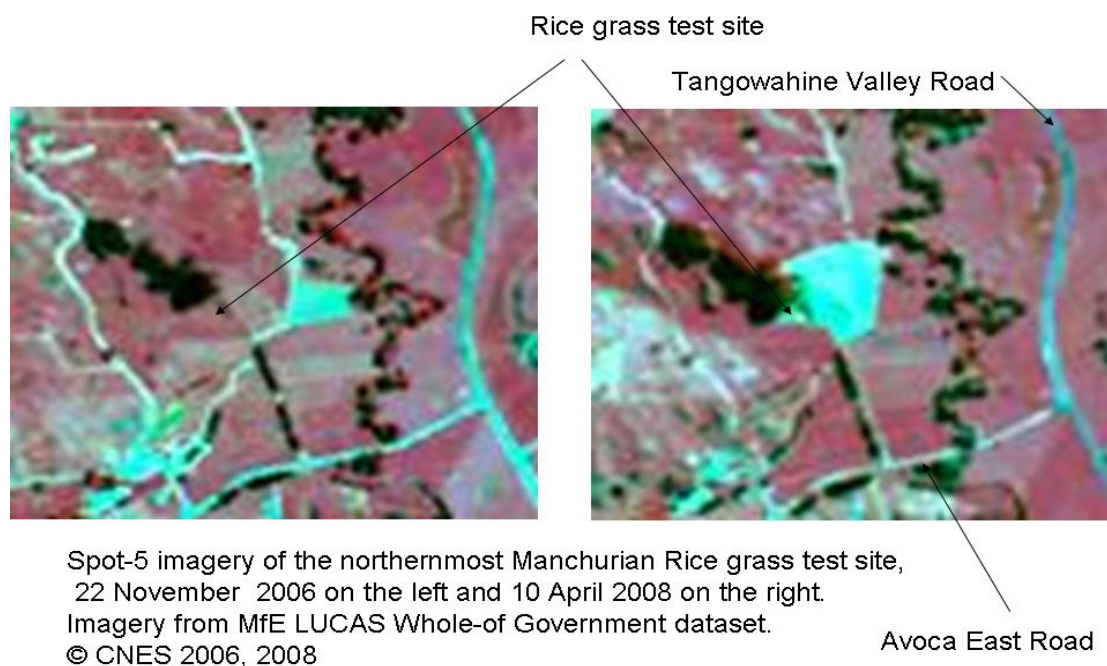


Fig. 2 Subscenes of Manchurian rice grass test site 1 from SPOT images.

Site 2: NZTM 1680245/6015235 NZMG 6577130/2590866 (P08) near Te Kopuru on the Wairoa River south of Dargaville

The site is in the bottom-right corner of a paddock on the corner of Taingaehe Road and the side road to Oturei Marae. In the KiwiImage/Quickbird imagery, the site appears a little more variable than the surrounding paddock, but with marginally less bare/non-vegetated ground. As with the northernmost site, some slight shadowing indicates that the vegetation here is tall enough to cause this. Figure 3 shows this test site.



Fig. 3 Subscene of multispectral Quickbird/KiwiImage data (standard false-colour composite) showing Manchurian rice grass test site 2 in the centre, just to the left of the intersection. © DigitalGlobe 2007.

Site 3: NZTM 1683683/6014734 NZMG 6576620/2594305

Site 4: NZTM 1683914/6014291 NZMG 6576176/2594535

Both near Mititai on the eastern side of the Wairoa River opposite Te Kopuru.

These sites appear to be a narrow drain/the grass verge running along the eastern side of the main road south from Dargaville. Not really visible in the Quickbird data and unnoticeable in the SPOT-5 imagery. No associated shadowing, as with the other two sites, is apparent. These two test sites are shown in Fig. 4.



Fig. 4 Subscene of multispectral Quickbird/KiwiImage data (standard false-colour composite) showing Manchurian rice grass test sites 3 and 4 running down the east side of the road from the centre of the image. Test site 4 runs into the cloud across the road. Neither patch if rice grass looks any different from the vegetation strips that are running across the image.
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4.3 Image processing

Thematic classification

Following the visual examination of the satellite images, thematic classifications of the two Quickbird/KiwiImage test sites were created. Each classification used a single rice grass test site: the dam (NZTM 1682432/6037859) for one and the paddock (NZTM 1680245/6015235) for the other. The other two test sites were too narrow to use to collect a representative spectral signature. Typically, a number of spectral signature samples would be collected for any given land cover class and great care is taken to assure that the samples are pure. Here, both samples were not only singular but also very small so the possibility for contamination from surrounding landcover classes cannot be ruled out. A number of spectral signatures for other landcovers – lush pasture, semi-bare pasture, bush, ponds, scrub, asphalt, bare ground, soil, river, cloud, shadow – were collected and maximum likelihood classifications run.

In both cases the classification maps confused the pasture classes with the rice grass class, resulting in thematic maps that were grossly overestimating, by at least 30%, rice grass coverage in either area. As the spectral signatures of the rice grass sample and the pasture

samples overlapped, this is not surprising. The signature was not being confused with the most vigorous pastures but with those that looked partly covered, perhaps actively grazed.

4.4 Principal component analysis

Principal component analysis is a technique used to create a linear transform of image bands in order to develop a new set of bands that are uncorrelated and ordered in terms of the amount of variance they are expressing. In theory, the new, reduced set of bands is easier to interpret. Sometimes, this methodology shows up classes/groups of features that were not apparent in the original data.

The two subscenes of Quickbird/KiwiImage data were run through principal components analyses for both three and four components. The four-component result was very noisy; the three-component result looked quite interesting in the pasturelands, and appeared to be giving clear information about the forest/bush but provided no new information for the Manchurian rice grass test site.

4.5 Object-oriented analyses

These were not attempted since they require the objects to be identified to have some unifying characteristics (shape, orientation) and the rice grass infestations can assume any size/shape.

5. Results

Neither the KiwiImage nor the SPOT-5 imagery showed a unique spectral response for Manchurian rice grass, either in standard spectral bands or in modified principal component analyses. Results may well have been the same with a larger sample set and with larger test samples. With such a small sample size and such tiny spectral samples, it may well be that our work has been carried out with no pure samples for the rice grass. However, none of the sites showed up as different from the surrounding vegetation so it is likely that there is no unique spectral signature for this species within the broad spectral bands of blue, red, green, and NIR. This does not mean that a/some narrow spectral band(s), such as that provided from hyperspectral aircraft scanners (such as CASI; see Walker 1993; Held et al. 2001; see also <http://www.es.ucsc.edu/~hyperwww/chevron/instruments.html>), might be suitable. If the opportunity to trial one of these scanners came up, we would recommend another trial.

Our results have also been restricted by the very poor Quickbird/KiwiImage coverage of Northland currently available, a factor we had not anticipated when this investigation was proposed. In hindsight, it would have been preferable to have delayed this work for at least a year.

6. Conclusion

- Based on a dataset limited by both coverage, available spectra (in the case of Quickbird/KiwiImage), spatial resolution (in the case of SPOT) and acquisition dates, we were unable to distinguish Manchurian rice grass from other vegetation types in Northland.

7. Recommendation

- Identification of small outlier sites of this pest plant is still best achieved by ground-based methods, unless either airborne or high-resolution satellite hyperspectral data becomes available.

8. Acknowledgements

We thank Don McKenzie and Peter Joynt of Northland Regional Council for providing the Manchurian Rice grass test site coordinates, Katrin Kussatz for assisting on the project, and Peter Williams for advice.

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