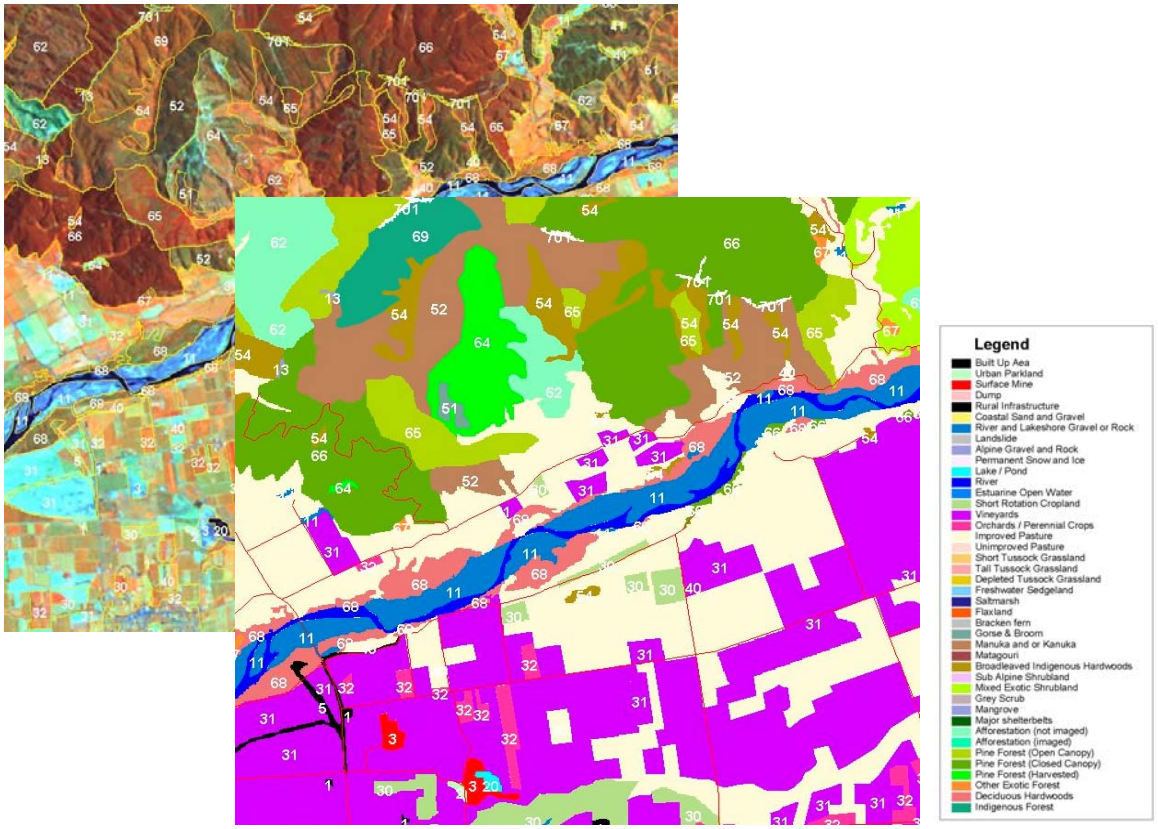
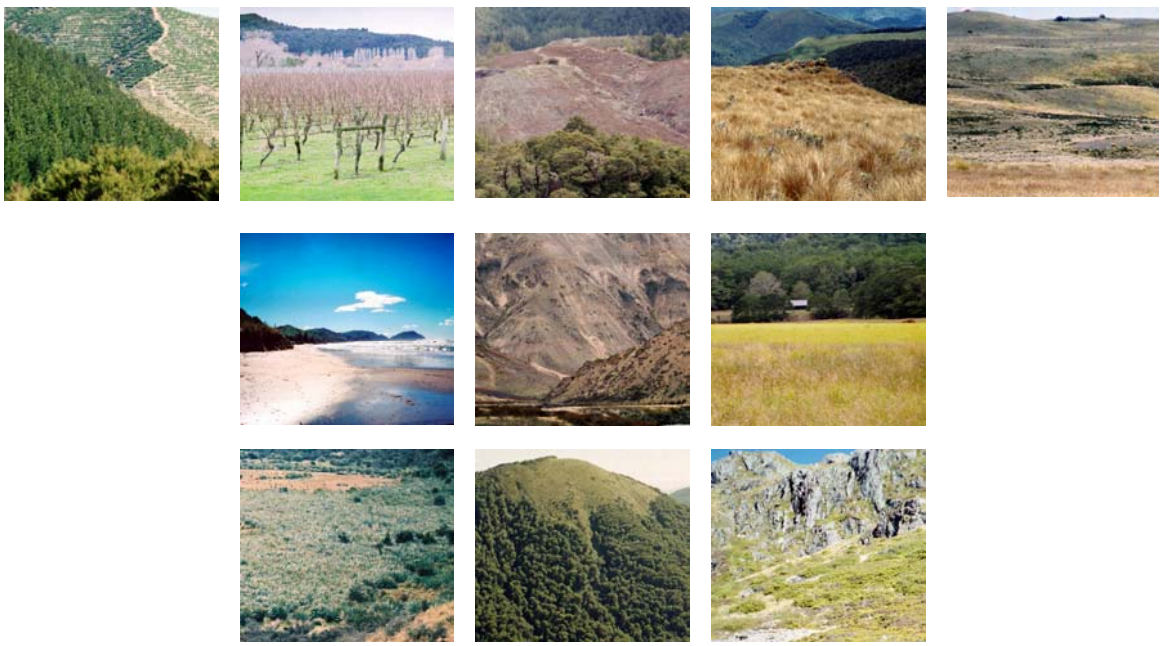
# New Zealand Land Cover Database Version 2

# Illustrated Guide to Target Classes



**Steve Thompson, Ingrid Grüner, Nelson Gapare**
**Ministry for the Environment, 2003**

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# Illustrated Guide to Target Classes

## THE PROJECT

The objective of the NZ Land Cover Database (LCDB) project is to establish and maintain a consistent land cover classification of known accuracy at a national level. Satellite imagery is used as the primary data source to classify land cover classes, and periodic updates of the database will enable land cover change to be assessed and reported on. These data are used for a range of Government reporting and monitoring functions.

## MAINTENANCE AND DISTRIBUTION

The Ministry for the Environment has been funded to produce the second version of the LCDB and stakeholders favour 5 yearly maintenance cycle for the database. Steve Thompson project managed the work and services were contracted for satellite image acquisition, image processing, image analysis and field checking, refer Attachment 1 for Project Workflow.

The LCDB is a Crown database and Ministry for the Environment, Ministry of Agriculture and Forestry and Department of Conservation are the key stakeholders. Results from the project will be made available via a database custodian to other users. Further refinement of the database to meet specific monitoring needs at sub-national scale is encouraged. The project was completed in June 2004.

## GUIDING PRINCIPLES

The classification is applicable to and consistent over the mainland and near-shore islands of New Zealand and the Chatham Islands. The target land cover classes are harmonised wherever possible with international land cover mapping initiatives, e.g., the FAO/UNEP Land Cover Classification System. The classification co-ordinates the requirements of central Government for national scale land cover inventory, monitoring and reporting. Maintenance of the classification is practicable and successive iterations of the database will over time, improve upon the classification accuracy achieved in LCDB1. Classification error identified in LCDB1 has been corrected to improve the accuracy of trend analysis between LCDB1 and LCDB2. LCDB1 now has equivalent classes to LCDB2.

The 43 target classes are mutually exclusive and additive to 100% of the surface area of New Zealand. The classification is hierarchical (i.e. aggregatable), derived from seven first order classes at the highest level, with an increasing number of more detailed classes at lower levels. The first order classes are based on the physiognomy of the land cover (i.e. grassland, shrubland, forest etc). Lower order divisions are based on other characteristics, such as phenology (Evergreen / Deciduous) and floristic composition (Broadleaved / Needleleaved).

Note: User accuracy is the probability that the class represented on the map is actually that class on the ground. For LCDB1, overall user accuracy was assessed at 93.9%, Dunningham et.al.

## EXPANDED DESCRIPTION OF TARGET CLASSES

The land cover classification scheme for Land Cover Database Version 2 (LCDB2) is a hierarchical development of the target classes used for LCDB1, which was derived from SPOT satellite imagery acquired over summer 1996 / 97. Of the original 18 classes, 6 remain unchanged and 12 have been expanded. LCDB1 and 2 now has 43 classes. The database retains the 1 ha Minimum Mapping Unit (MMU) used for LCDB1. This is necessary to ensure valid change analysis between LCDB1 and LCDB2. Refer to Attachment 1 for an overview of the land cover classification hierarchy applicable to the New Zealand mainland and near shore islands and Attachment 2 for classes applicable to the Chatham Islands.

Consistent threshold values (% cover) separating the individual classes (e.g., high producing exotic grassland vs. depleted tussock grassland have been established through field

inspection. Threshold values may vary between classes depending on the reflectance values of the respective target classes, as priority is given to the classes being separable in the imagery.

The dominant cover decides the class a vegetation type is assigned. This means in most cases a cover of more than 50%, but can be less if the vegetation represents a mosaic of three or more classes. Class descriptions are expanded upon and illustrated in this report.

LCDB2 used the Landsat 7 ETM+ sensor, and the imagery has been pan-sharpened to 15m spatial resolution. All imagery was acquired during summer 2001/02. The spectral resolution of Landsat 7 improves the separability of land cover classes compared to the SPOT 2 and 3 sensors used for LCDB1. The accuracy of the increased number of classes in LCDB2 was maintained through an intensive field programme that gathered training data which was used to inform image classification as well as field checking draft maps and the project also utilised ancillary data such as vegetation surveys, plot data and aerial photography. Refer Attachment 3 for an illustration of the project workflow.

**The land cover classification is structured into the following "first order" classes:**

1 Artificial surfaces
11 Bare or lightly vegetated surfaces
111 Water bodies
1V Cropland
V1 Grassland, Sedgeland, Saltmarsh
V11 Scrub and/or Shrubland
V111 Forest

Definitions and field views of the LCDB2 target classes are provided on the following pages. Illustrations of the satellite imagery were subset from the Landsat ETM+ scenes using ArcView 3.2 and ERDAS IMAGINE. The image subsets use band combination of 4,5,3 for the red, green, and blue bands, respectively.

## Artificial Surfaces

### 1 Built-up Area:

Built-up areas comprise central business districts, suburban dwellings, commercial and industrial areas, and horticultural sites dominated by structures and sealed surfaces (e.g., glasshouses). The class includes immediately associated hard surfaces and infrastructure such as roads, carparks and paved areas. Low density residential areas are also included. Note: artificial surfaces associated with transport infrastructure will comprise a separate class, see Class 5 for details.

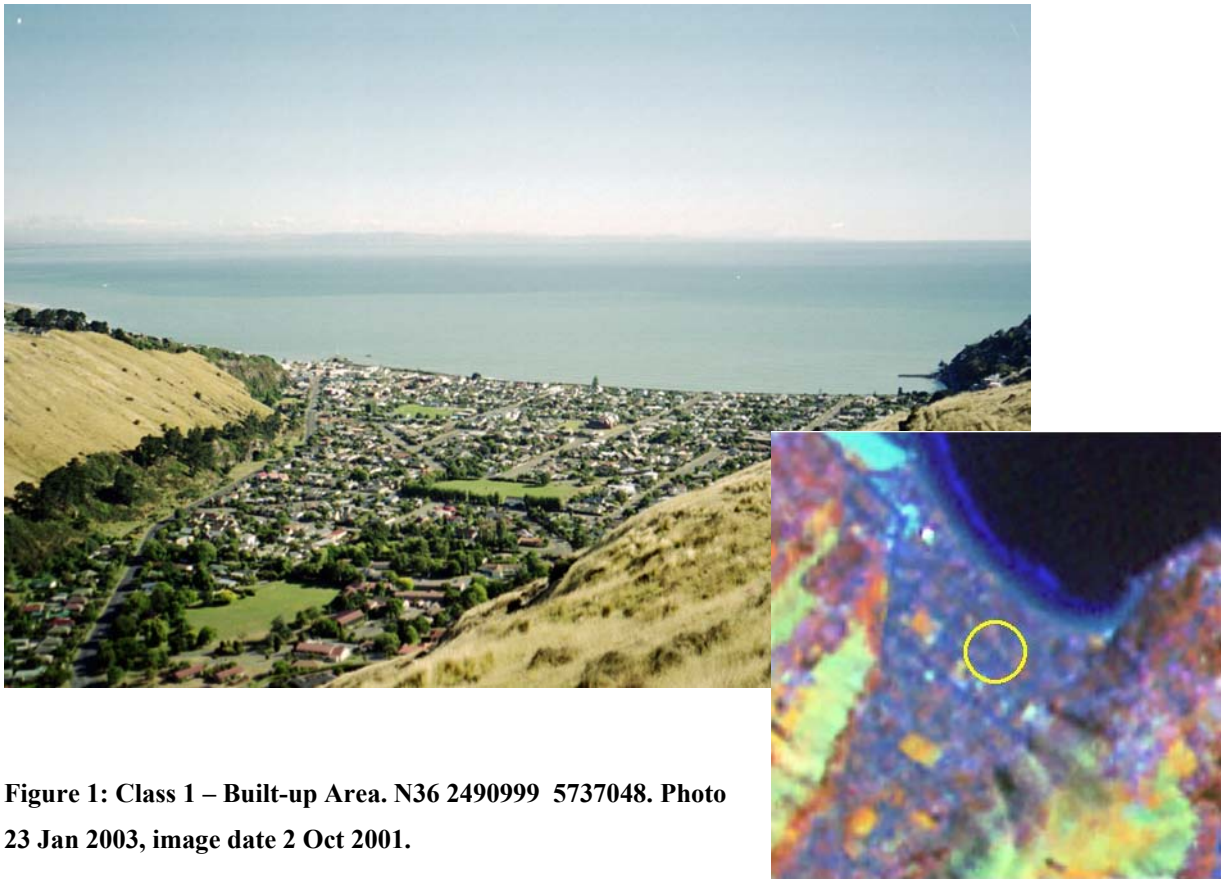


**Figure 1: Class 1 – Built-up Area. N36 2490999 5737048. Photo 23 Jan 2003, image date 2 Oct 2001.**

## 2 Urban Parkland / Open Space:

Open, typically mown, grassed amenity areas within or associated with built-up areas. The class includes parks with scattered trees, playing fields, cemeteries, airports, golf courses, and river berms. Areas of hard surface, buildings and trees or scrub within Urban Parkland / Open Space, that are larger than the MMU are classified separately.

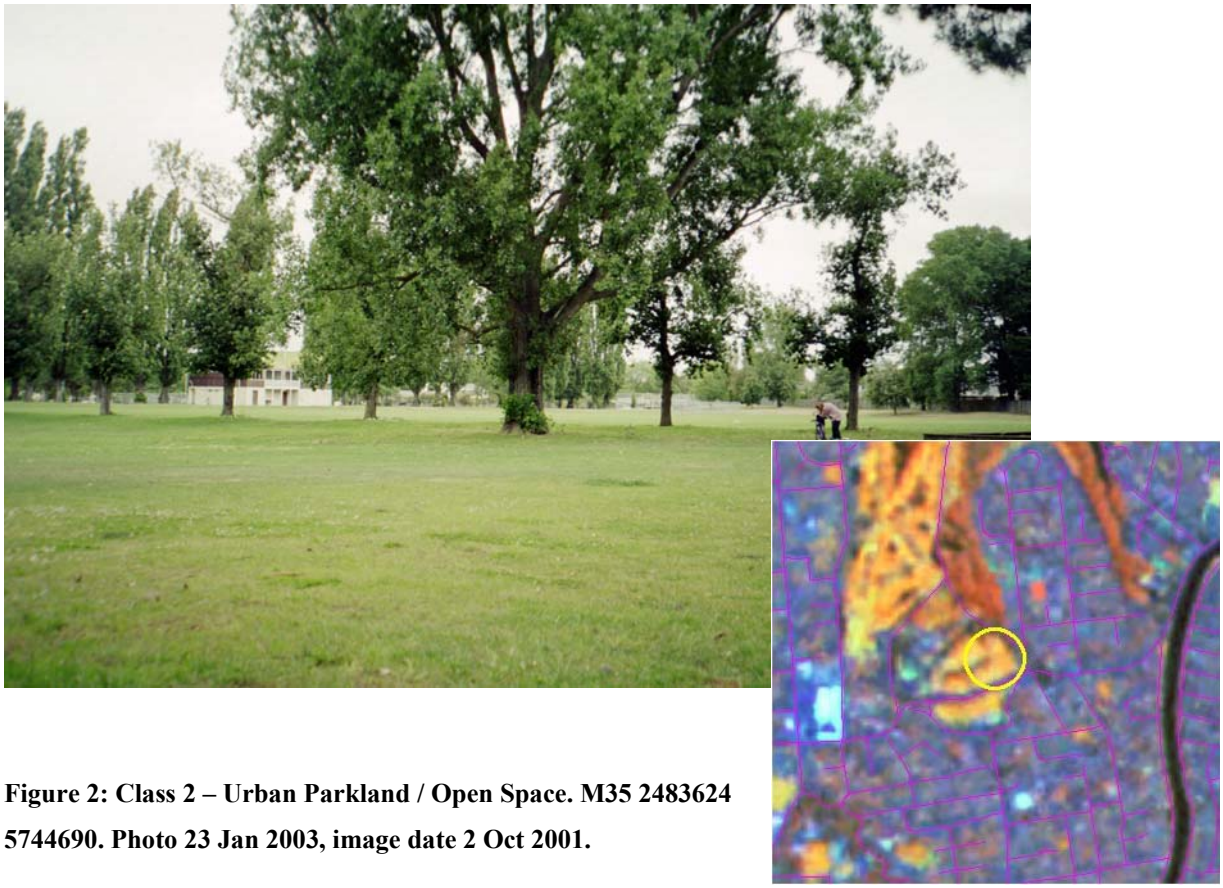


**Figure 2: Class 2 – Urban Parkland / Open Space. M35 2483624 5744690. Photo 23 Jan 2003, image date 2 Oct 2001.**

## 3 Surface Mine:

Culturally derived bare surfaces such as gravel pits and other open quarries.

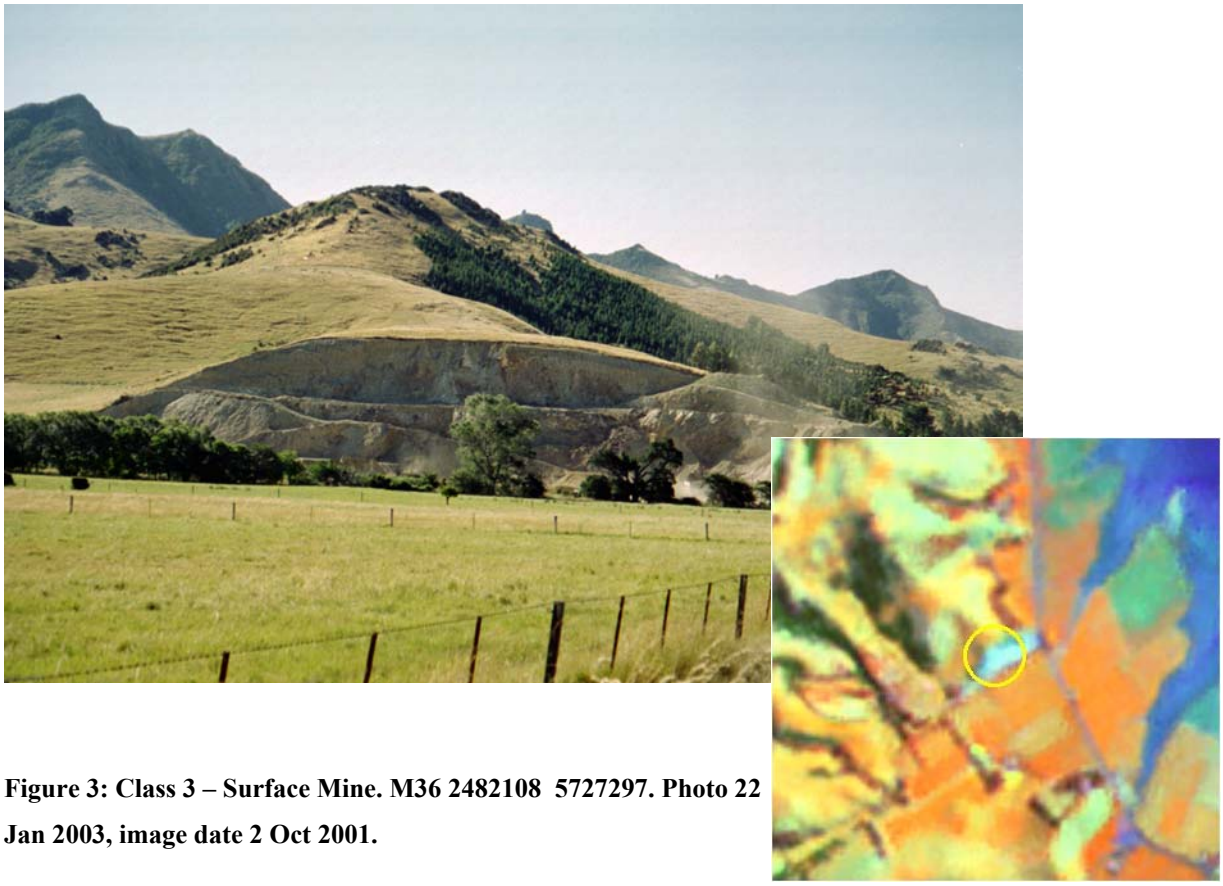


**Figure 3: Class 3 – Surface Mine. M36 2482108 5727297. Photo 22 Jan 2003, image date 2 Oct 2001.**

## 4 Dump:

Areas used for the surface disposal of solid waste material.

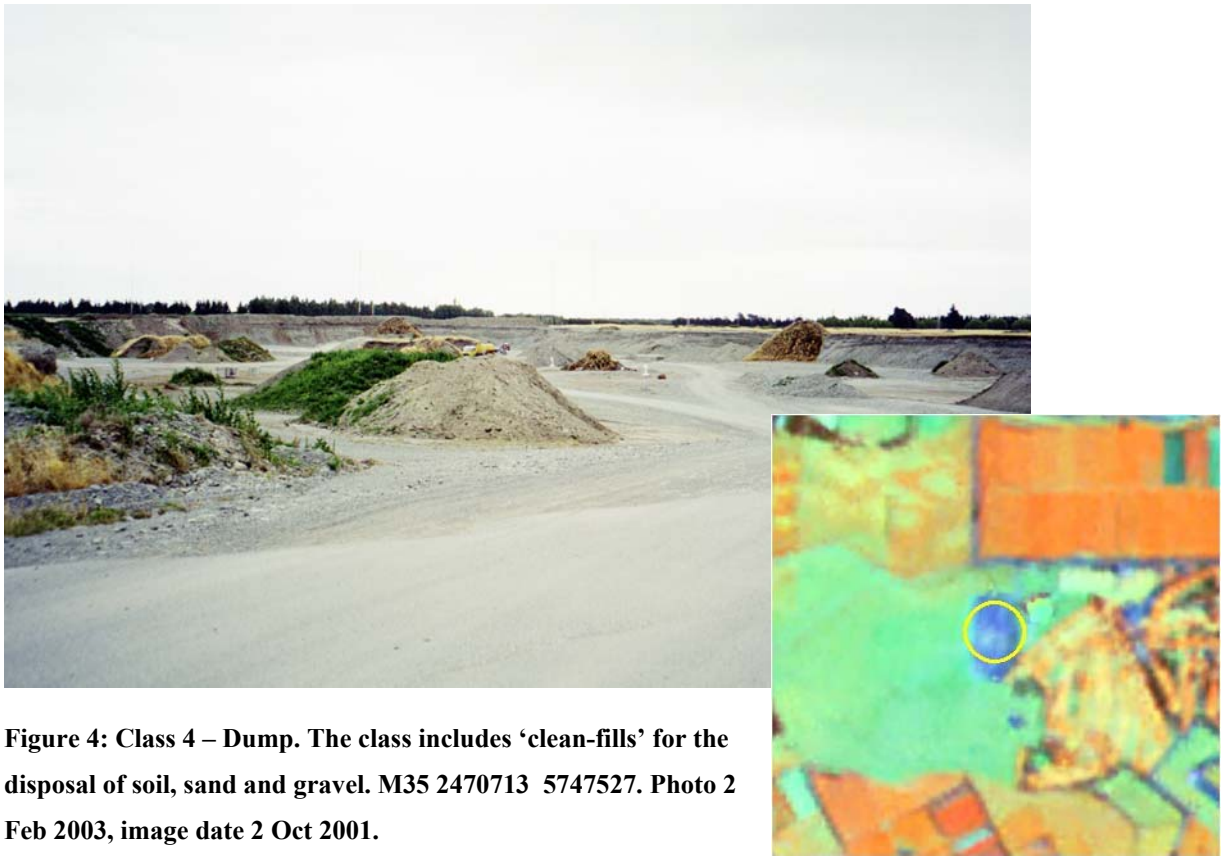


**Figure 4: Class 4 – Dump. The class includes 'clean-fills' for the disposal of soil, sand and gravel. M35 2470713 5747527. Photo 2 Feb 2003, image date 2 Oct 2001.**

## 5 Transport Infrastructure:

Includes artificial surfaces such as roads, railroads, airport runways and skid sites associated with forest logging, where these features are discernable and exceed the 1 ha MMU.

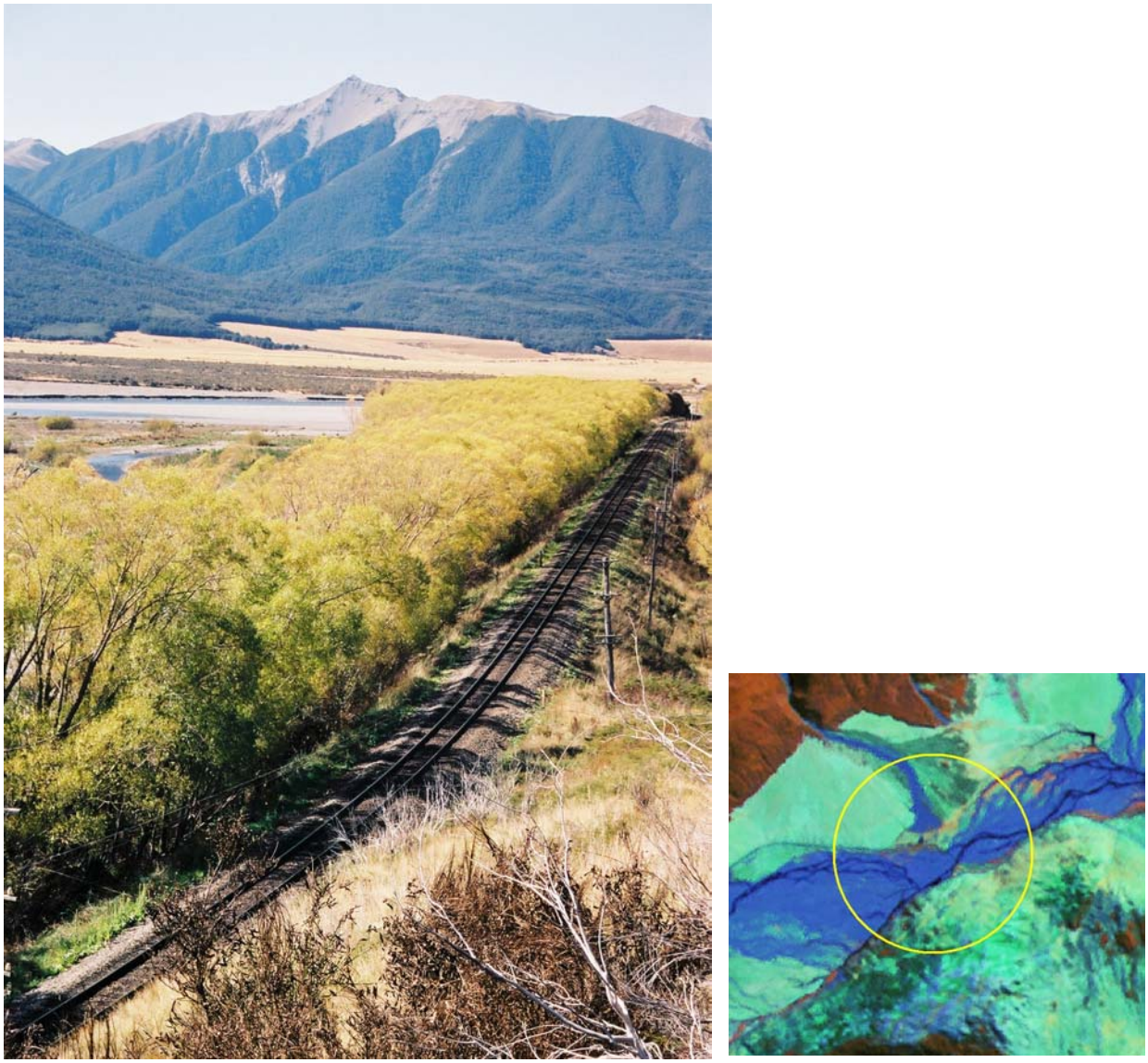


**Figure 5: Class 5 – Transport Infrastructure. K34 2405390 5798612. Photo 16 April 2002 image date 02 Oct 2001.**

## Bare or Lightly Vegetated Surfaces

### 10 Coastal Sand, Gravel, and Rock:

The coastal strip of land that falls on the landward side of the "coastline" as defined in the NZ Topo data. This convention is necessary as the area of coastal sand or mudflat imaged at sensor overpass is tide dependent.

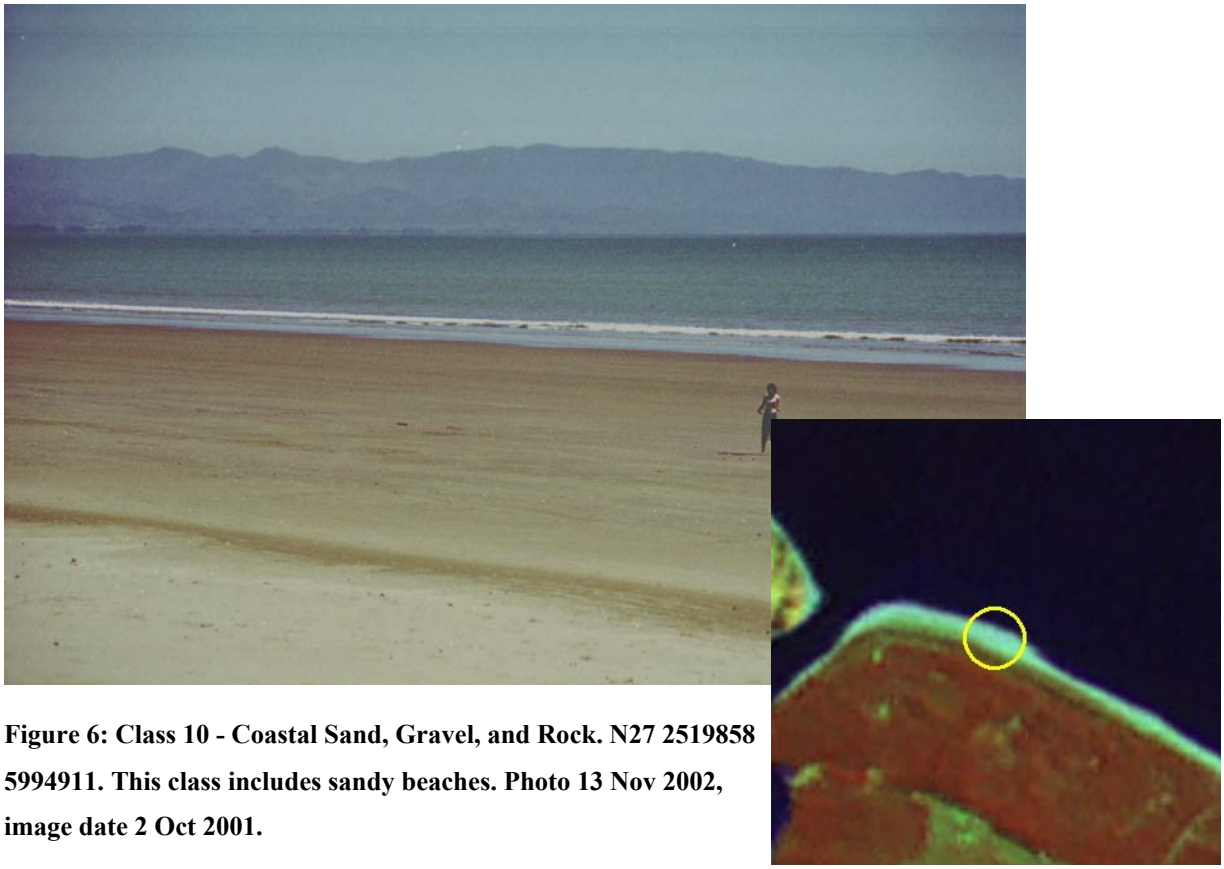


**Figure 6: Class 10 - Coastal Sand, Gravel, and Rock. N27 2519858 5994911. This class includes sandy beaches. Photo 13 Nov 2002, image date 2 Oct 2001.**

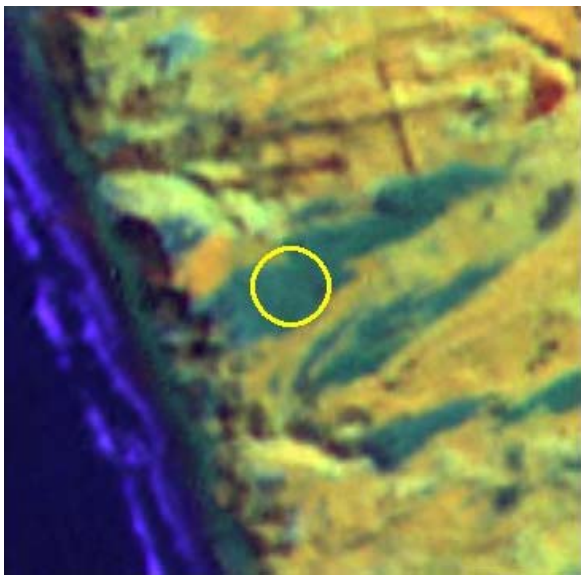


**Figure 7: The class includes areas of exposed sand originating from old dune systems. R12 2656473 6436474. Image date 25 Sept 2001.**

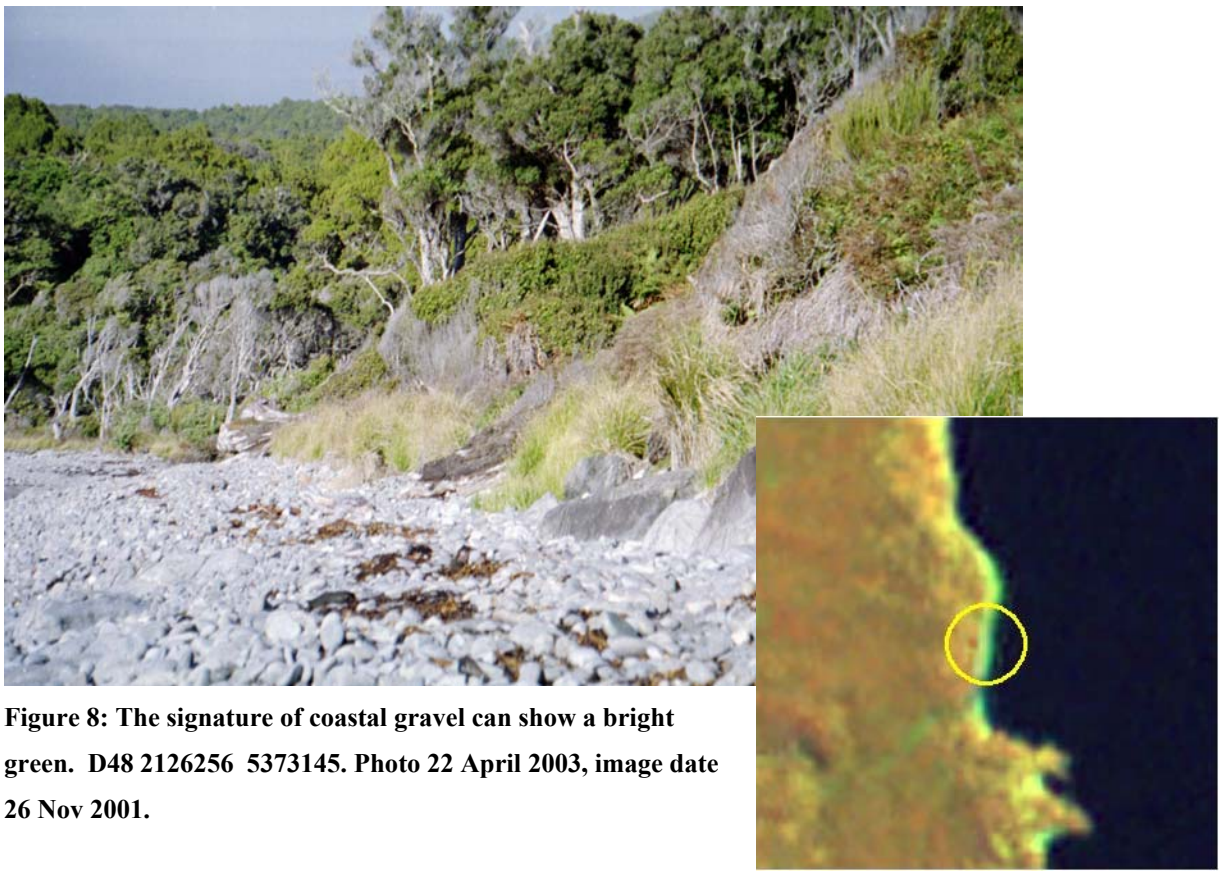


**Figure 8: The signature of coastal gravel can show a bright green. D48 2126256 5373145. Photo 22 April 2003, image date 26 Nov 2001.**

## 11 River and Lakeshore Gravel and Rock:

Areas adjacent to rivers, streams and lakes characterised by bare gravel, sand and rock. These are generally recent surfaces and vegetation, if present, is not apparent in the imagery, although lichen and moss cover may be extensive. The exact extent of areas adjacent to rivers is dependent on the water levels at the time of image acquisition. The extent of lakeshore gravel and rock is based on the maximum water levels documented in either NZ Topo data or the 2001/02 satellite imagery. The class also includes areas of bare ground associated with thermal activity.

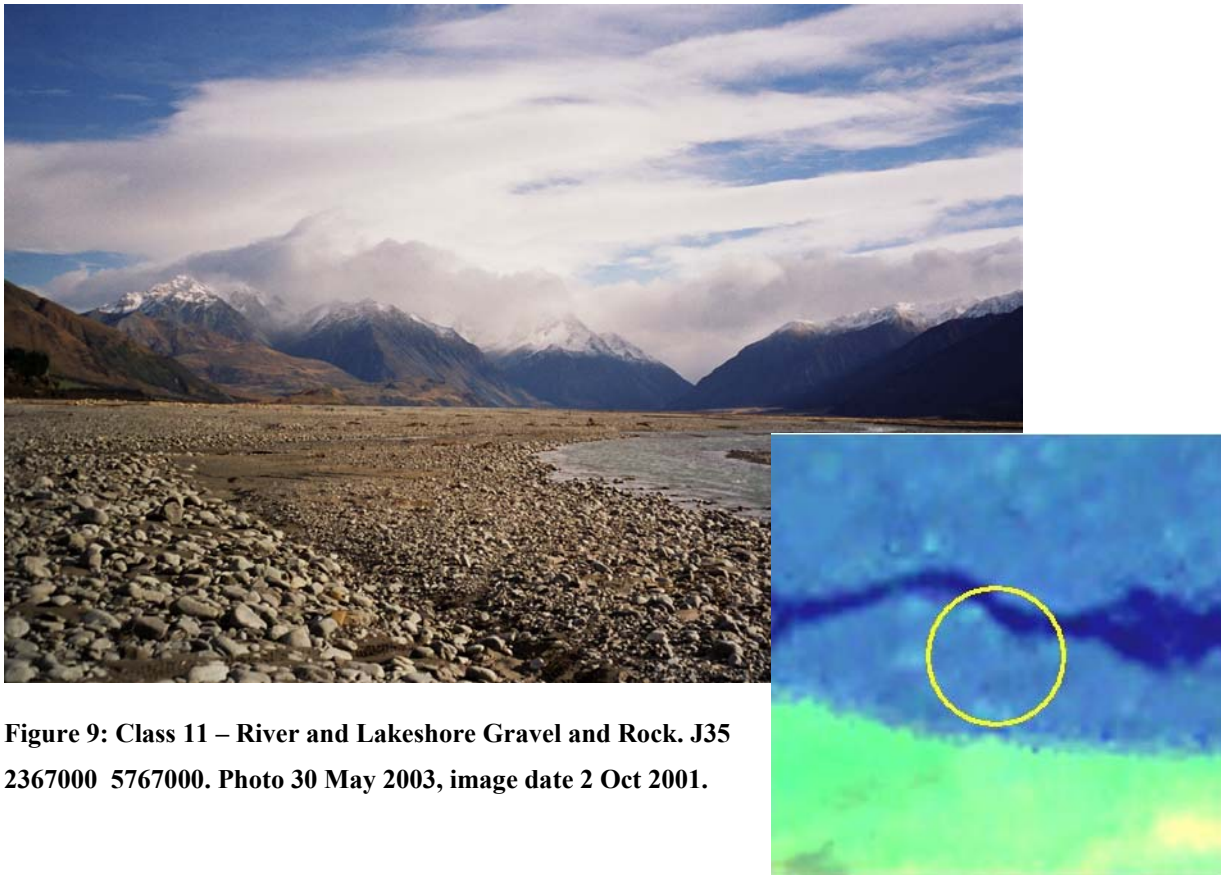


**Figure 9: Class 11 – River and Lakeshore Gravel and Rock. J35 2367000 5767000. Photo 30 May 2003, image date 2 Oct 2001.**

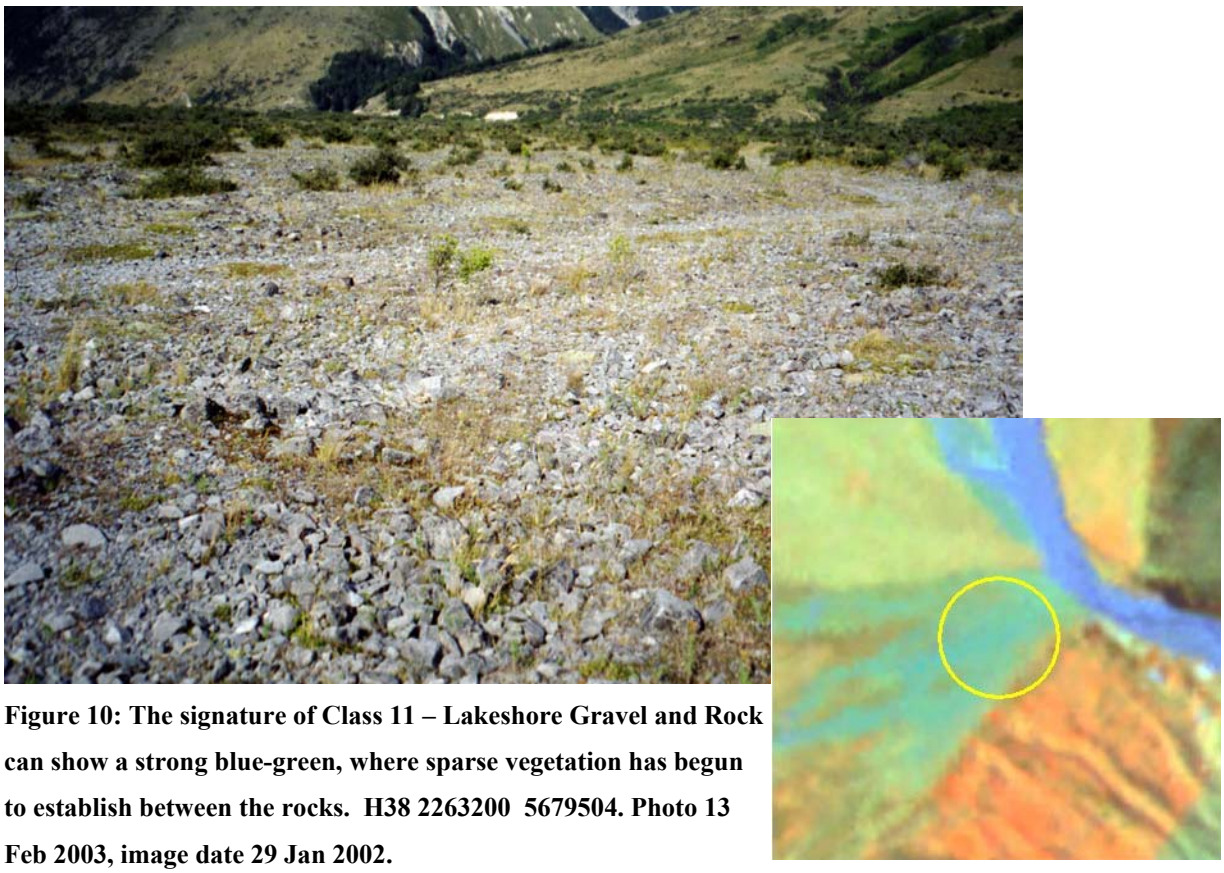


**Figure 10: The signature of Class 11 – Lakeshore Gravel and Rock can show a strong blue-green, where sparse vegetation has begun to establish between the rocks. H38 2263200 5679504. Photo 13 Feb 2003, image date 29 Jan 2002.**

## 12 Landslide:

Areas of subsoil and parent material exposed due to a *localised* erosion event. The class is generally associated with grassland land cover classes, but does occur on forested land as a consequence of torrential rainfall or earthquake.

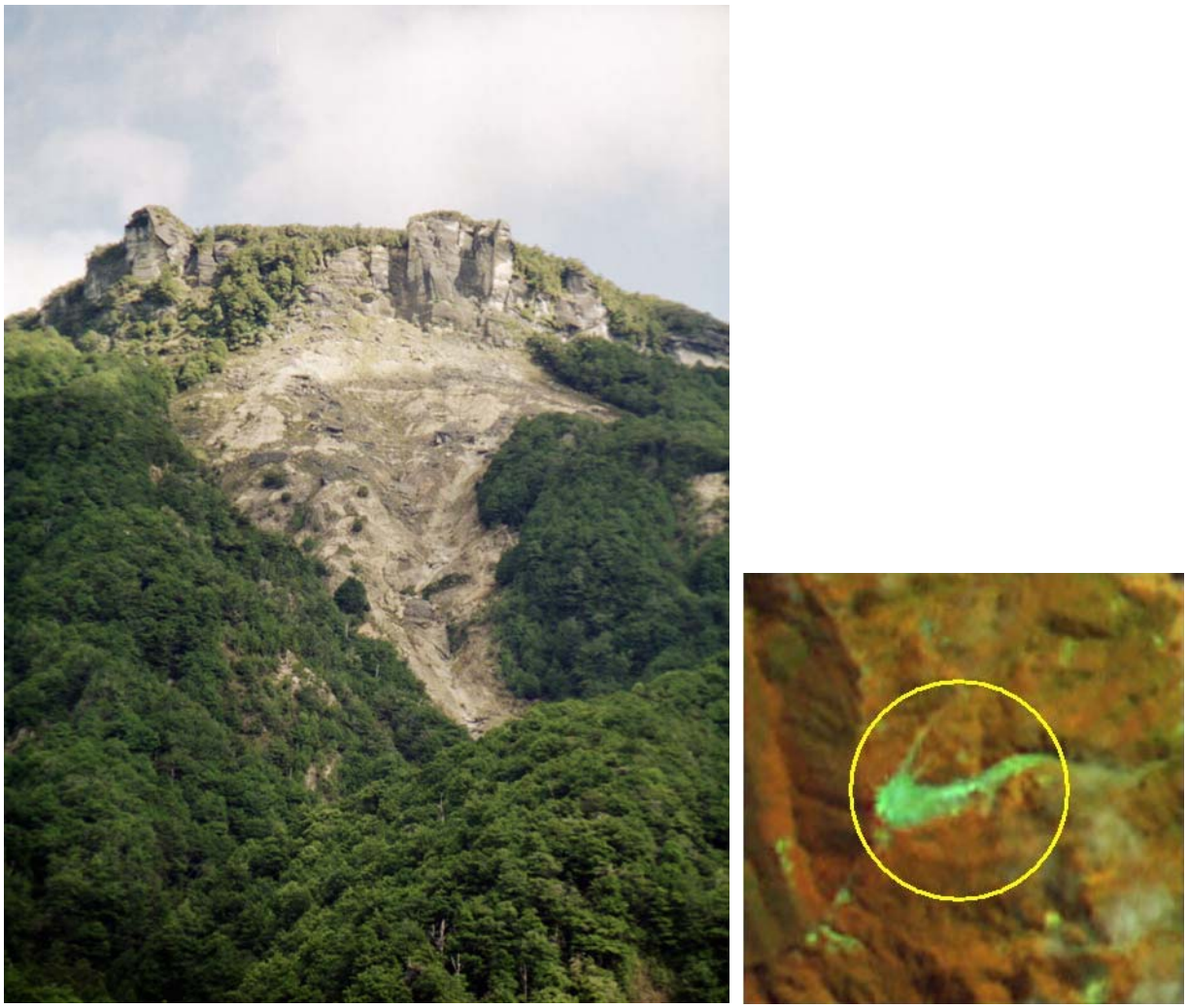


**Figure 11: Class 12 – Landslide. M30 2452339 5917349. Photo 14 March 2003, image date 2 Oct 2001.**

## 13 Alpine Gravel and Rock:

A class mainly represented in the Southern Alps above an altitude of approximately 1300m, but includes scree slopes and glacial debris, as well as rock tor areas, throughout the hill and high country of New Zealand. Dominant cover is solid or fractured rock, mostly greywacke and argillite. Surfaces are recent and vegetation, if present, is of very low biomass and not apparent in the imagery.

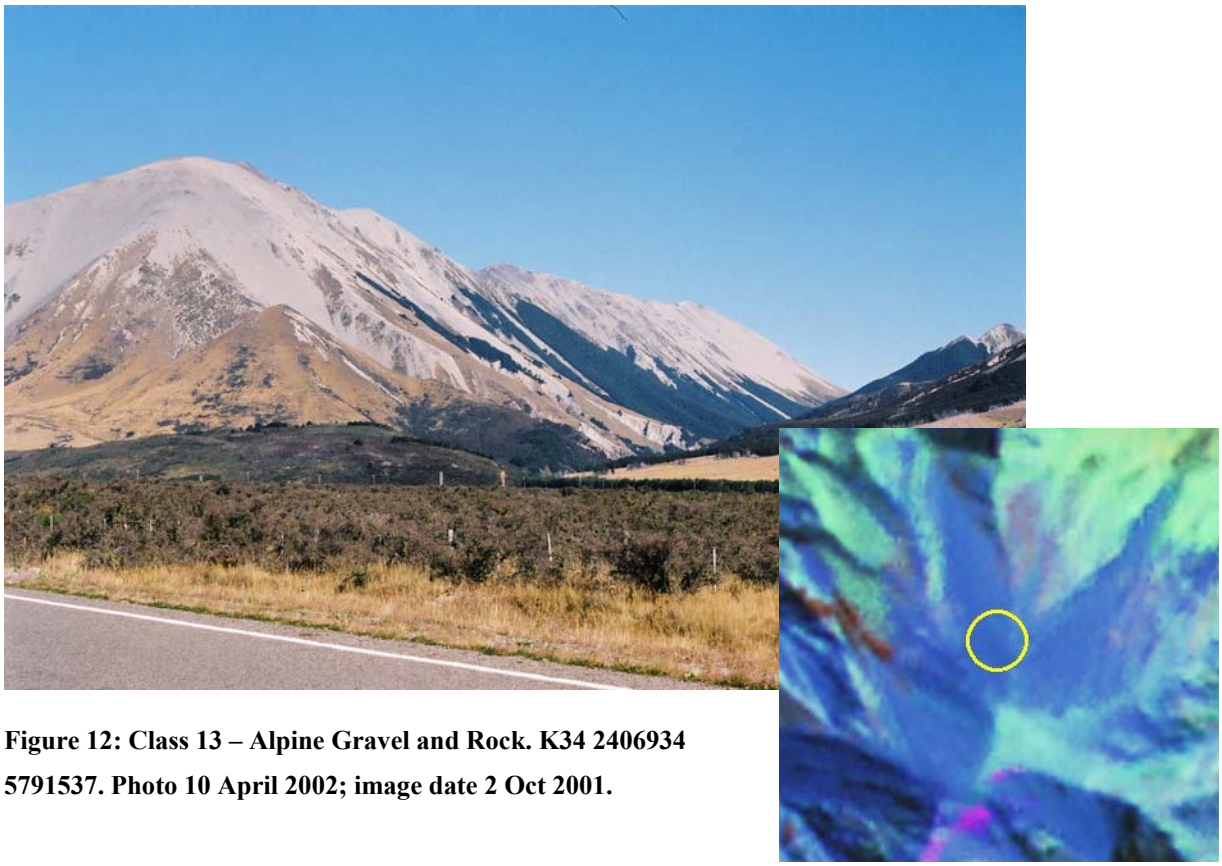


**Figure 12: Class 13 – Alpine Gravel and Rock. K34 2406934 5791537. Photo 10 April 2002; image date 2 Oct 2001.**

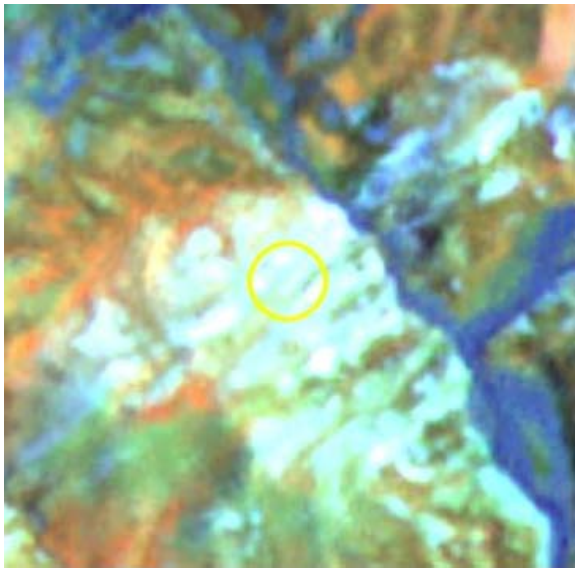


**Figure 13: Areas of bare limestone show a white signature in the imagery. O30 2561045 5902299. Image date 30 Dec 2001.**

## 14 Permanent Snow and Ice:

Areas characterised by a perennial cover of snow and / or ice. Extensive and permanent snowfields are restricted to areas above 1800m in the Southern Alps, the summit of Mt Ruapehu, and shaded southerly aspects of the Fiordland mountains south of latitude 45°. The class includes glaciers that drain the most significant alpine snowfields and extend to lower altitudes. The extent of Permanent Snow and Ice is based on the *minimum* area documented in either NZ Topo data or the 2001/02 satellite imagery.

**Figure 14: Class 14 – Permanent Snow and Ice. F39 2177122 5643061. Photo 4 Feb 2003, image date 29 Jan 2002.**

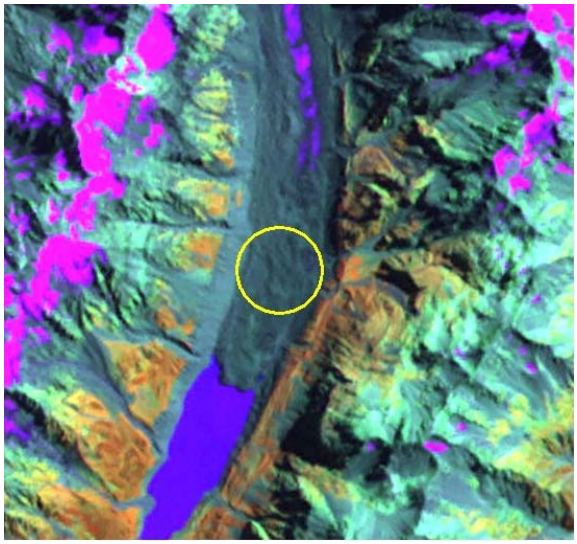


**Figure 15: Permanent Snow and Ice show a dark grey signature when covered with top moraine material. H36 2277587 5722829. Image date 13 Feb 2002.**

## 15 Alpine Grass-/Herbfield

Areas of vegetation above the tree line, dominated by low growing and mat forming herbs and grasses. The bare ground component in this land cover type is typically very high, and areas are usually associated with Class 13 - Alpine Gravel and Rock. Sites do not have a history of pastoral use.

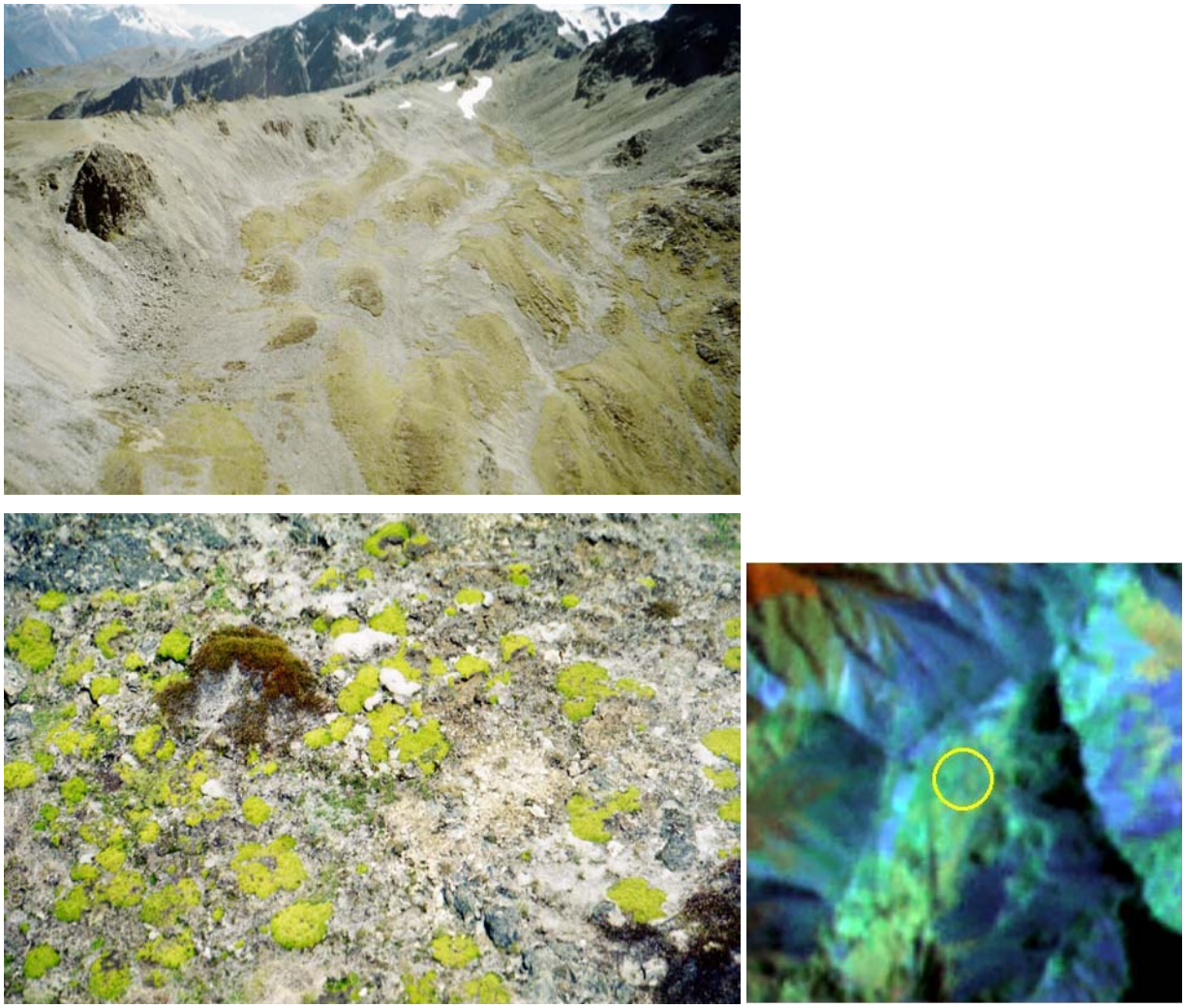


**Figure 16: Class 15 – Alpine Grass-/Herbfield. G38 2231224 5654269. Photo 2 Feb 2003, image date 29 Jan 2002.**

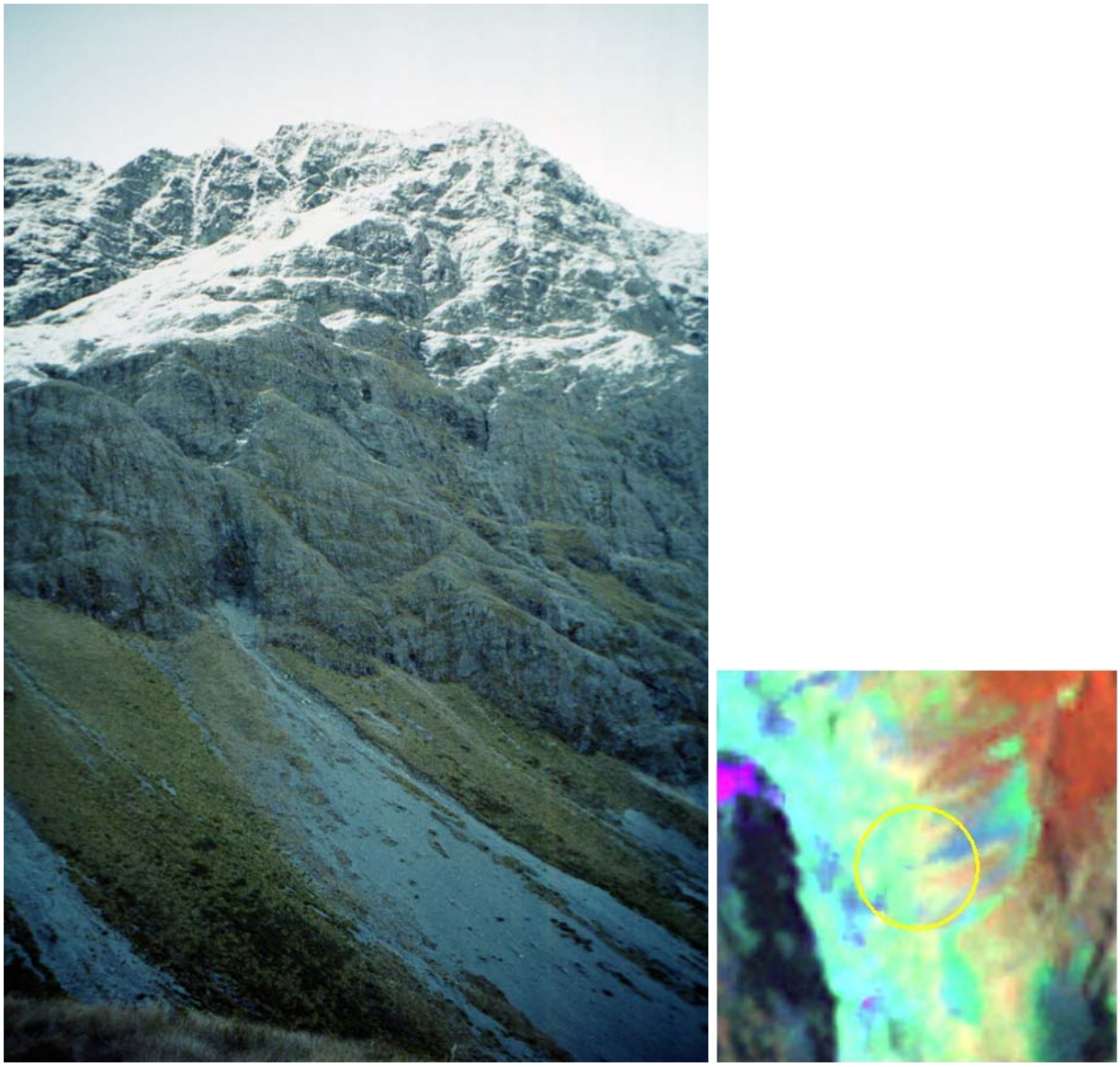


**Figure 17: Areas of Class 15 - Alpine Grass-/Herbfield are usually found adjacent to scree and bare rock (Class 13). At lower altitude, they grade into Class 43 - Tall Tussock Grassland or Class 55 – Subalpine Scrub. E41 2131549  5582758. Photo 13 May 2003, image date 20 Jan 2002.**

## Water Bodies

### 20 Lake or Pond:

Areas of permanently or intermittently, standing open fresh water without emerging vegetation (lacustrine systems). The class includes natural water bodies, such as lakes and ponds, as well as artificial water bodies, such as oxidation ponds, fire control ponds, and reservoirs. The area of standing open freshwater reflects the maximum extent documented in either the 2001/2002 satellite imagery or NZ Topo data.

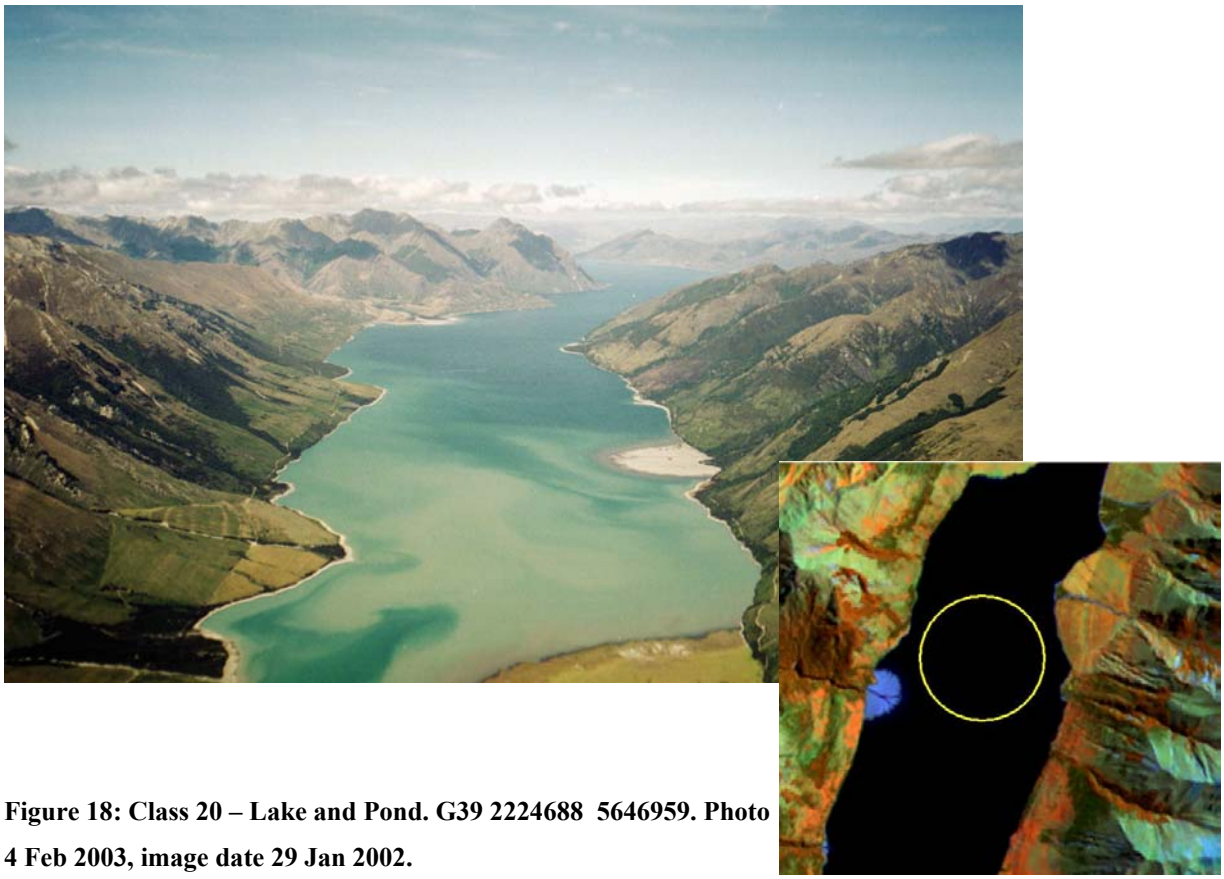


**Figure 18: Class 20 – Lake and Pond. G39 2224688 5646959. Photo 4 Feb 2003, image date 29 Jan 2002.**

## 21 River:

Areas of flowing open freshwater without emerging vegetation (riverine systems). The class includes natural and modified rivers, creeks, canals, and channels. The area of flowing open freshwater reflects the water levels at time of image acquisition, and is limited to water bodies exceeding a width of 30 m (2 pixels). Rivers are bounded downstream by Estuarine Open Water, which has a saline influence.

**Figure 19: River channels in a braided river bed show the dark blue signature of water. The adjacent gravel (Class 11) is characterised by a lighter blue. K35 2382549 5762760. Photo 29 May 2003, image date 2 Oct 2001.**

## 22 Estuarine Open Water:

Areas of standing or flowing open water without emerging vegetation, where occasionally or periodically saline waters are diluted by freshwater, or freshwater is made saline. The class includes the estuaries of rivers, lagoons, and dune swales. The area of estuarine open water reflects the *maximum* extent documented in either the satellite imagery or NZ 260 Topodata.

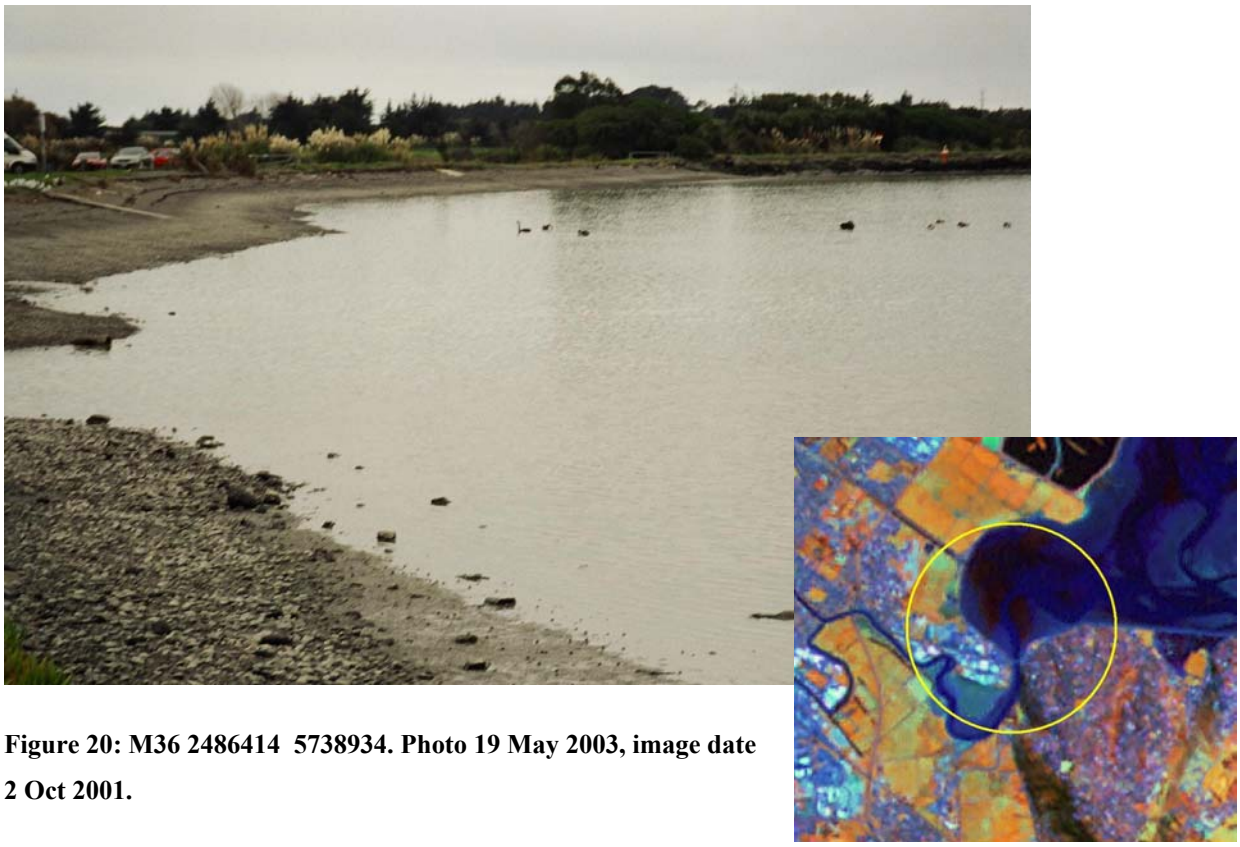


**Figure 20: M36 2486414 5738934. Photo 19 May 2003, image date 2 Oct 2001.**

## Cropland

### 30 Short-rotation Cropland:

Land generally found within the developed agricultural landscape on plains, terraces and down-land having a spectral signature indicating that soil has been exposed by cultivation or indicating crop types that typically involve regular, at least, annual cultivation. The class includes land used for growing cereal crops, root crops, annual seed crops, annual vegetable crops, hops, strawberry fields, annual flower crops, and open ground nurseries. Land lying fallow at the time of imaging is also included unless the field survey determined that cultivation was for pasture renewal. In these cases the cultivated area is assigned to Class 40 - High Producing Exotic Grassland.

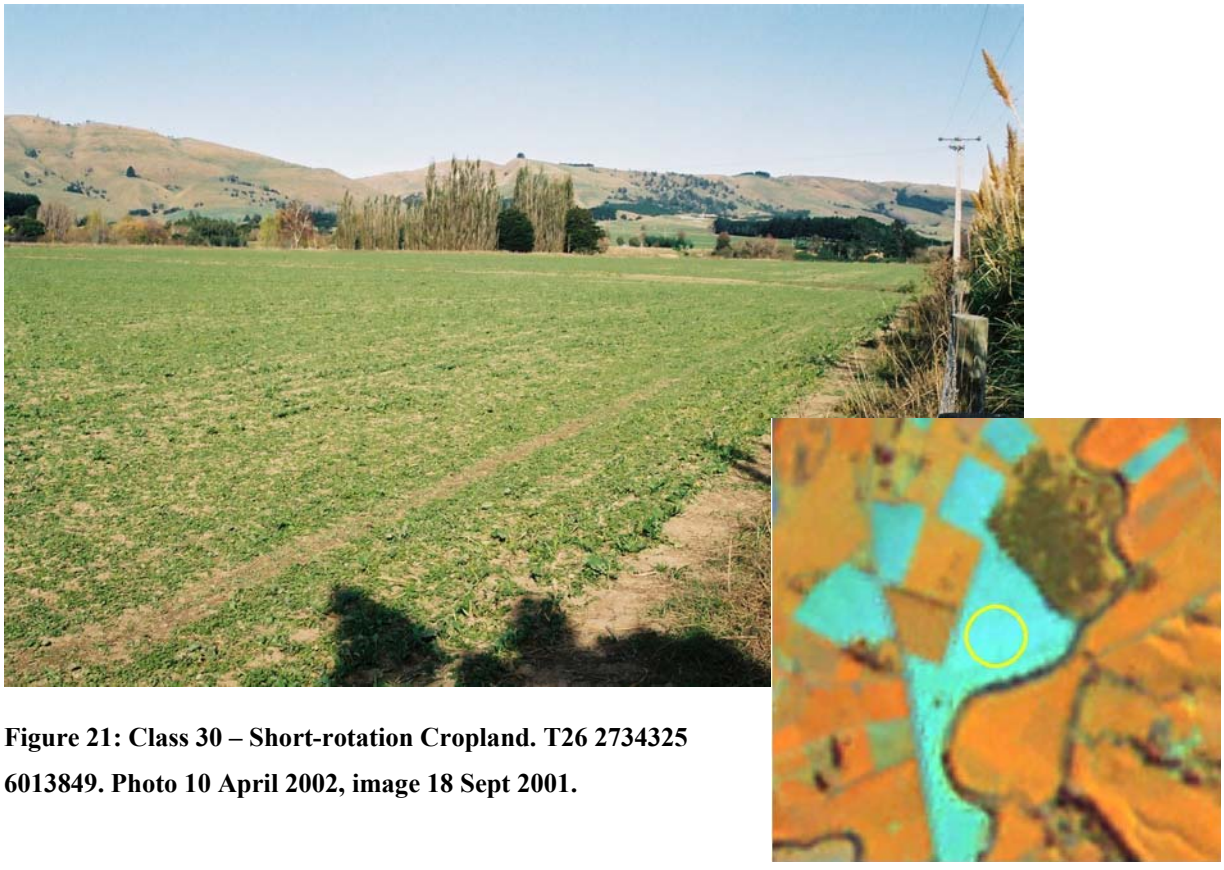
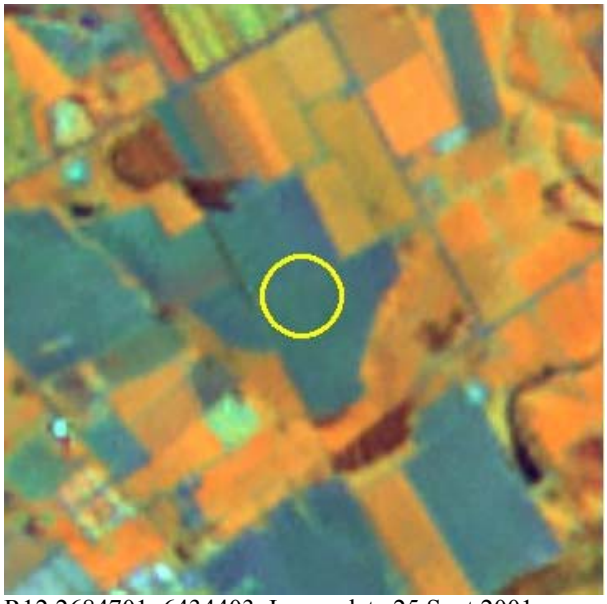
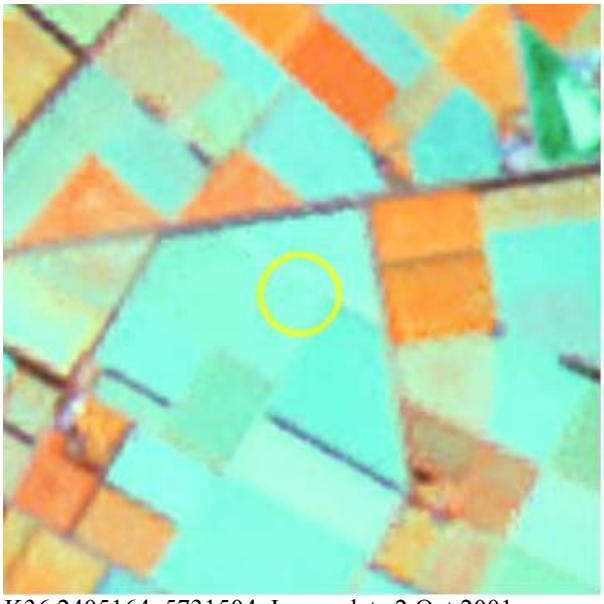


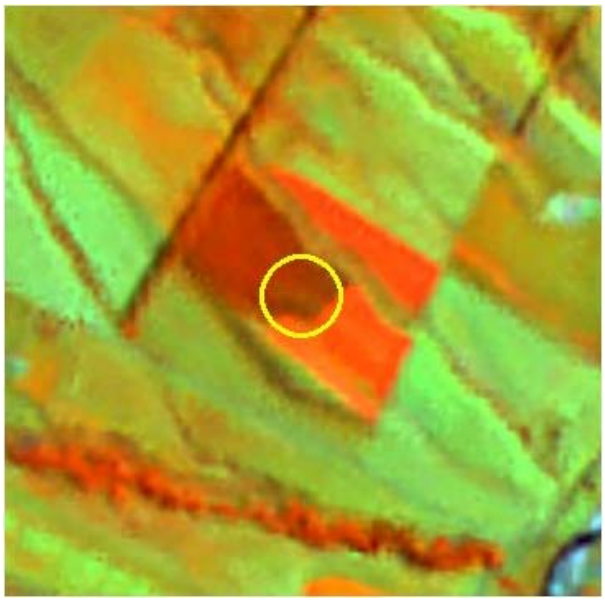
**Figure 21: Class 30 – Short-rotation Cropland. T26 2734325 6013849. Photo 10 April 2002, image 18 Sept 2001.**



R12 2684701 6434403. Image date 25 Sept 2001.



K36 2405164 5731504. Image date 2 Oct 2001.



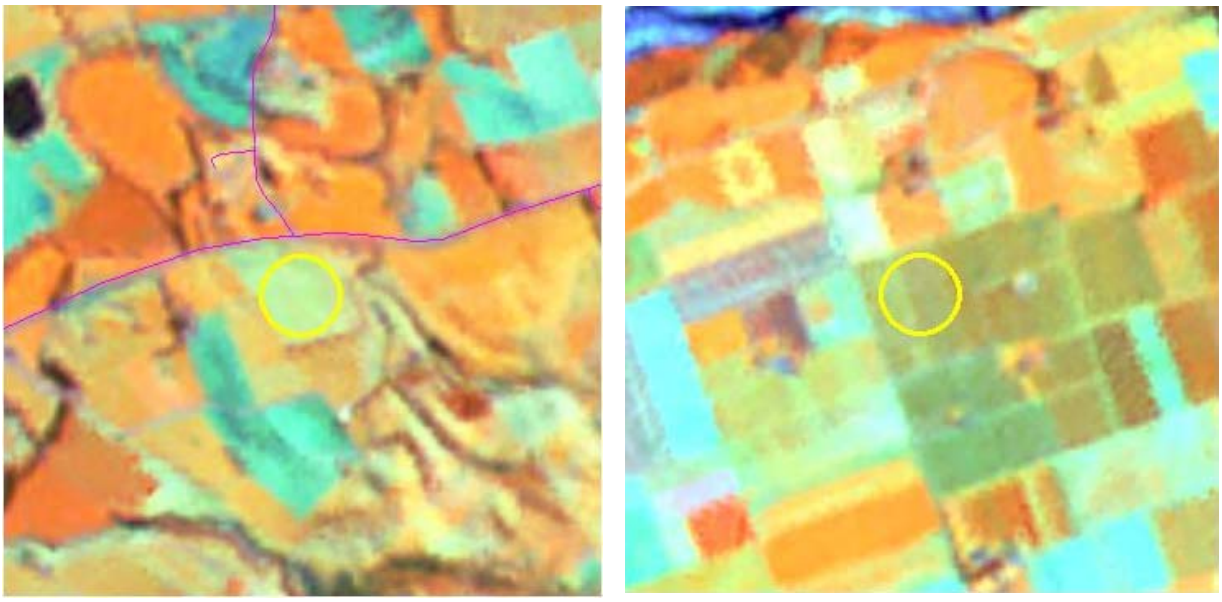
I39 2323186 5624718. Image date 29 Jan 2002.

**Figure 22: Class 30 – Short-rotation Cropland. The areas show either a bare ground signature indicating cultivation, or a bright red signature indicating crop biomass in excess of the surrounding pasture.**

## 31 Vineyard:

Land occupied by rows of perennial vines supporting grape crops usually harvested for the production of wine.

**Figure 23: Class 31 – Vineyard. N34 2493091 5796615. Photo 28 Feb 2002, image date 2 Oct 2001.**

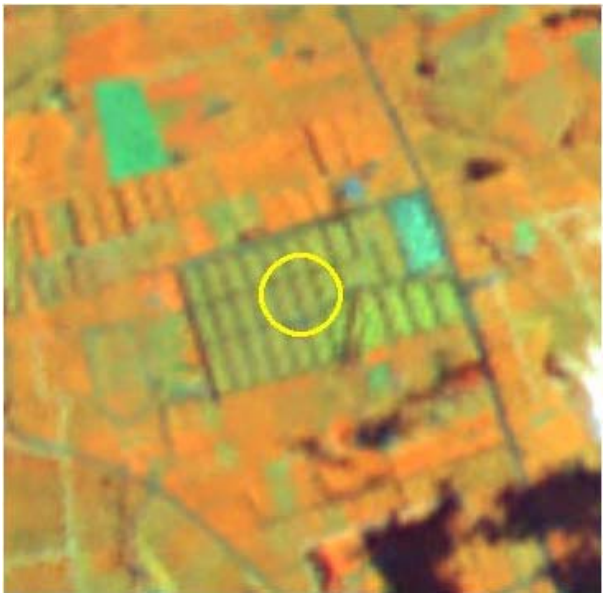


N34 2494536 5796821. Image date 2 Oct 2001. P28 2584765 5971799. Image date 30 Dec 2001.

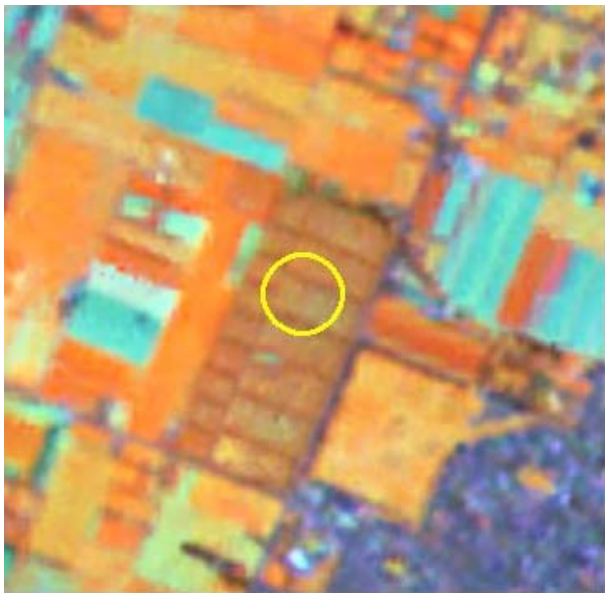
**Figure 24: The signature of vineyards varies depending on the age of the grapevines and the type of ground cover between the rows.**

## 32 Orchards and Other Perennial Crops:

Orchards and areas cultivated less than annually, and used for producing tree crops, such as pip fruit, stone fruit, nuts, olives, and citrus fruit, as well as crops grown on shrubs or climbing plants, such as berries, kiwifruit, and asparagus.



Kiwifruit orchard. R12 2669431 6448874.
Image 25 Sept 2001.



Pip- and stonefruit orchard. M35 2472799 5744512.
Image date 2 Oct 2001.

**Figure 25: Orchards are characterised by a dense grid of shelterbelts over a distinct signature reflecting the crop grown.**

## Grassland

### 40 High Producing Exotic Grassland:

This class comprises areas of exotic grassland characterised by a spectral signature indicating good vigour of the vegetation cover. Typically, these areas are intensively managed exotic grasslands, rotationally grazed for wool, lamb, beef, dairy, and deer production. These pastures are usually found on land that can be cultivated and are subject to a 'long-rotational' cycle with pasture renewal every 5-10 years. Productivity is enhanced through fertiliser application and in some areas, irrigation. Dominant species are usually clovers (*Trifolium* spp.) and highly productive pasture grasses, such as ryegrass (*Lolium perenne*) and cocksfoot (*Dactylis glomerata*). However, the class also includes areas of extensively managed exotic grasslands that show lush growth due to inherently high soil fertility or high annual rainfall. In these grasslands low productive grasses, such as browntop (*Agrostis capillaris*) and sweet vernal (*Anthoxanthum odoratum*), can be dominant.

As the vigour of grassland vegetation is seasonal, the class boundaries and consequently the reported areas of High Producing Exotic Grassland Low Producing Grassland (Class 41) reflect the dates of image acquisition.

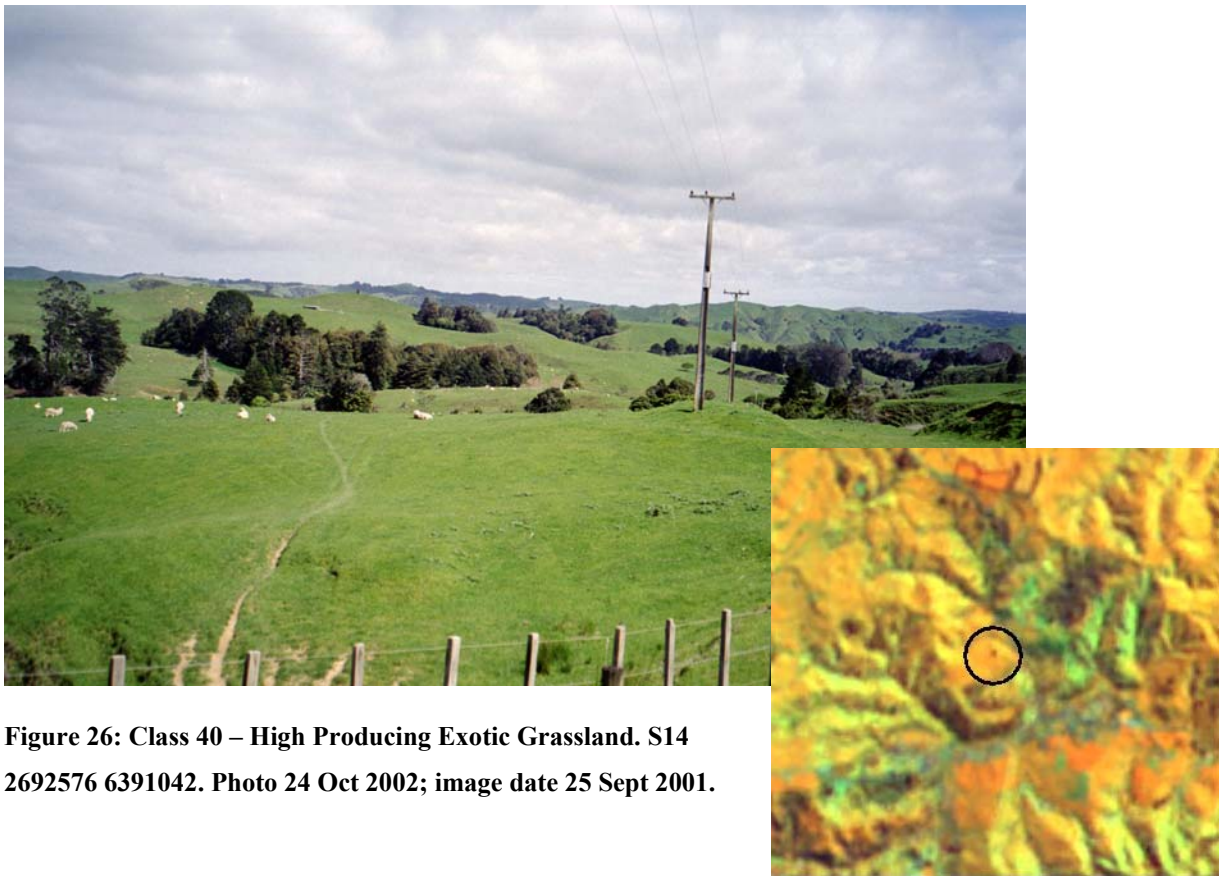


**Figure 26: Class 40 – High Producing Exotic Grassland. S14 2692576 6391042. Photo 24 Oct 2002; image date 25 Sept 2001.**

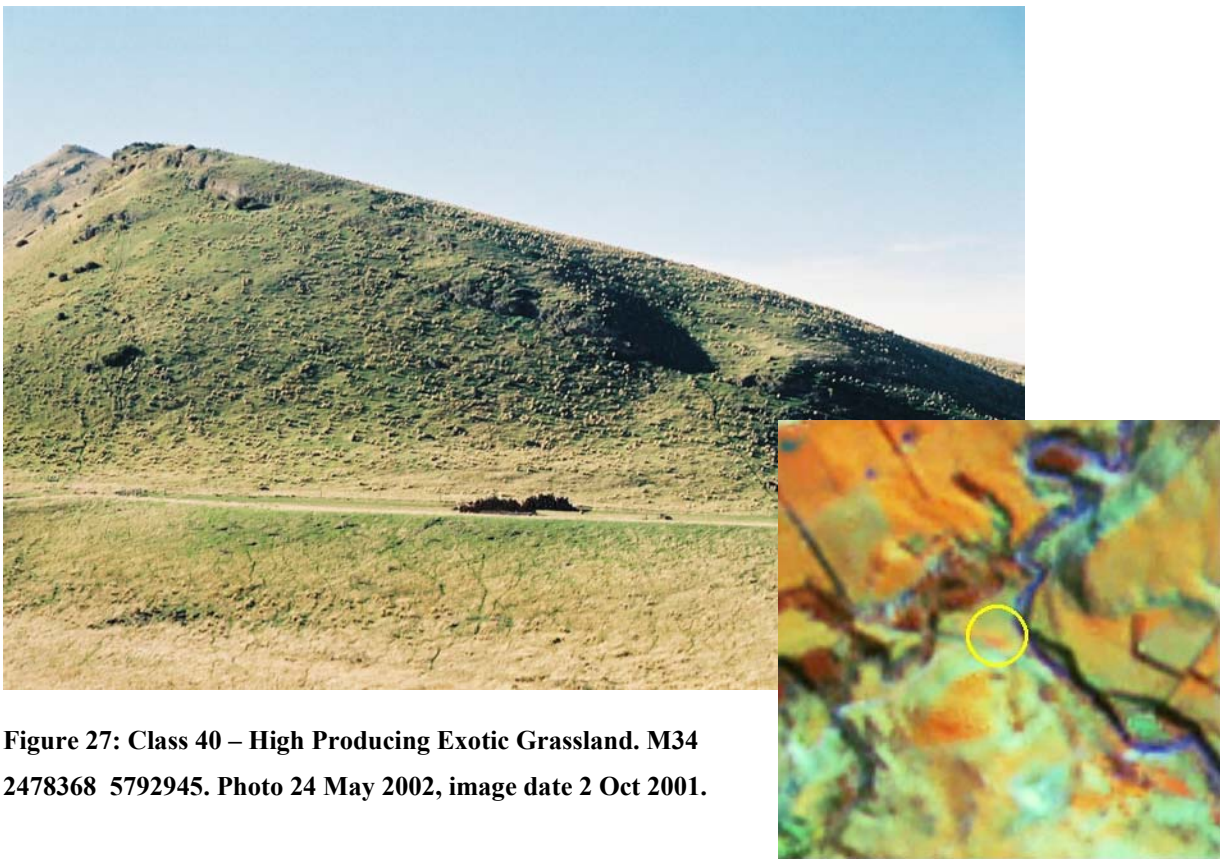


**Figure 27: Class 40 – High Producing Exotic Grassland. M34 2478368 5792945. Photo 24 May 2002, image date 2 Oct 2001.**

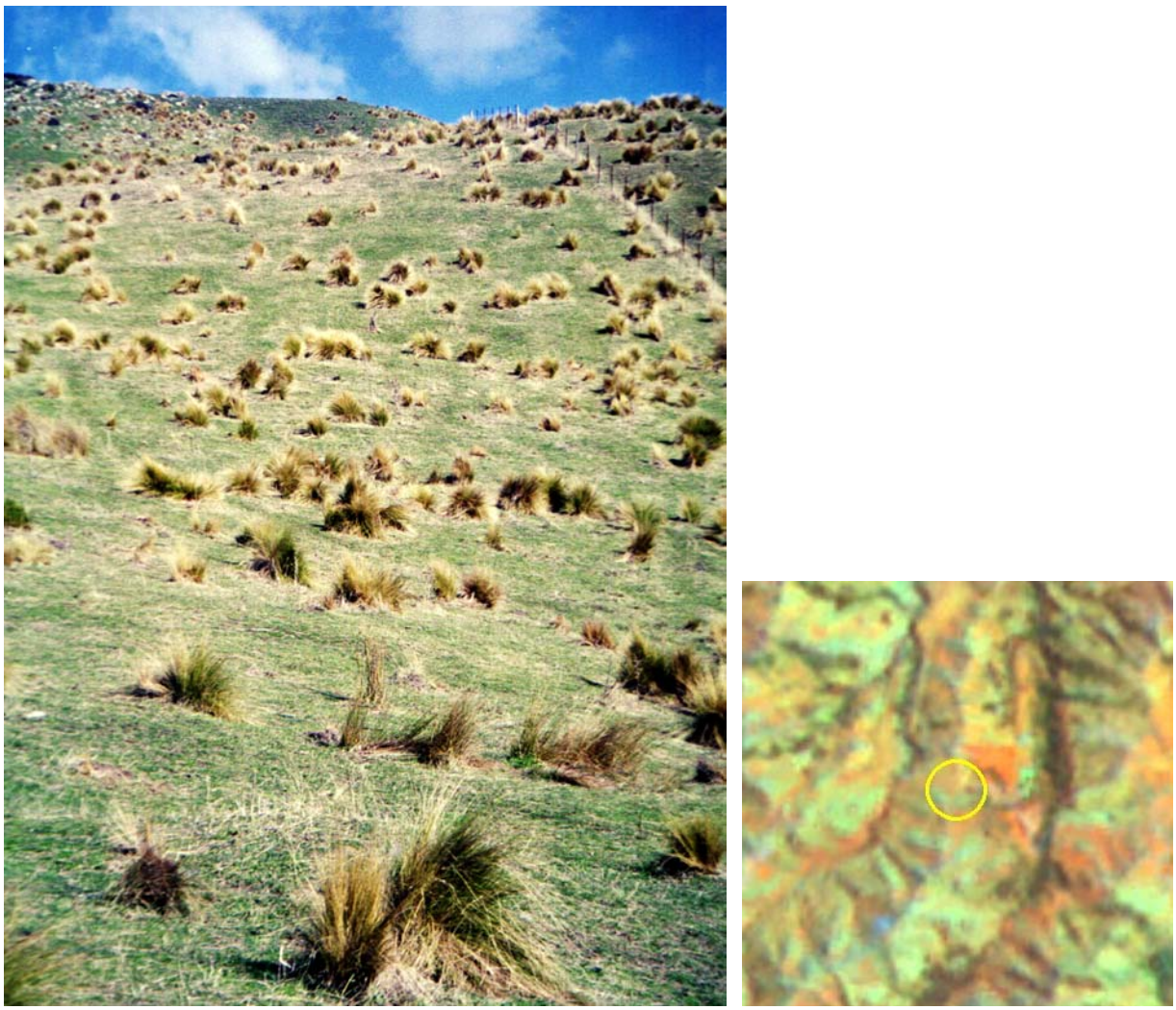


**Figure 28: Class 40 – High Producing Exotic Grassland. P29 2594297 5932524. Photo 27 Sept 2002; image date 30 Dec 2001.**

**41 Low Producing Grassland:**

This class comprises areas of exotic and indigenous grasslands characterised by a spectral signature indicating lower plant vigour and biomass compared to Class 40 – High Producing Exotic Grassland. The reduced vigour reflects lower levels of inherent soil fertility, lower fertiliser application, seasonal drought, or a shorter growing season, especially in the South Island.

Typically the class comprises extensively managed grasslands grazed for wool, sheep-meat and beef production. It is usually found on steep hill and high country throughout New Zealand, often intermixed with areas of High Producing Exotic Grassland on more accessible and fertile sites.

Dominant species are less productive exotic grasses, such as browntop (*Agrostis capillaris*) and sweet vernal (*Anthoxanthum odoratum*), usually mixed with indigenous short tussock species. Areas of Low Producing Grassland show a tendency to "brown off" during summer months. Paddock size is generally larger than in areas of Class 40 . In wetter areas, scrub reversion is evident on sites less accessible to stock.

This class also includes areas of short tussock grassland such as hard tussock (*Festuca novae-zelandiae*), blue tussock (*Poa colensoi*), and / or silver tussock (*Poa cita*). Exotic grasses are usually present, however as a minor component. Short tussock grasslands can be extensively managed for fine wool, sheep-meat, beef and deer production, ungrazed areas exist as part of the conservation estate. The class is typically found in low rainfall valleys and montane basins eastward of the Southern Alps and in the North Island volcanic plateaux.

As the vigour of grassland vegetation is seasonal, the class boundaries and consequently the reported areas of High Producing and Low Producing Grassland reflect the dates of image acquisition.

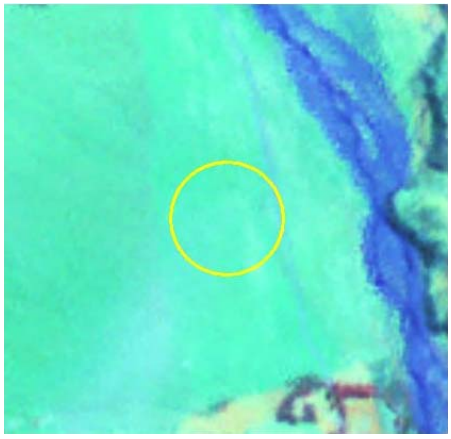


**Figure 29: Area of low producing grassland are dominated by introduced grass species, such as sweet vernal (*Anthoxanthum odoratum*) and browntop (*Agrostis capillaris*). J36 2361568 5732672. Photos 24 March 2003, image date 2 Oct 2001.**

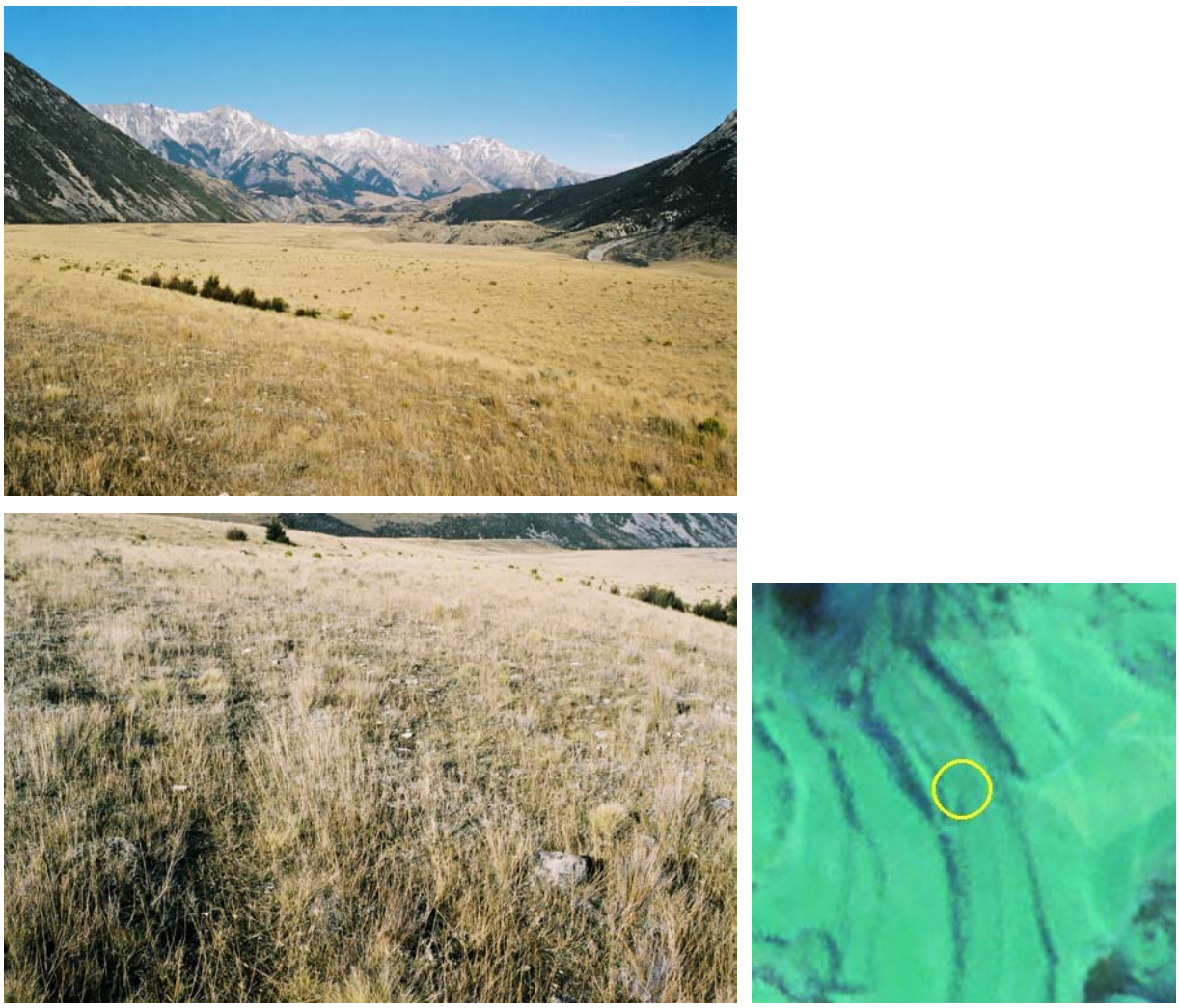


**Figure 30: Class 41 – Low Producing Grassland. L34 2415366  5783705. Photo 30 May 2002; image date 2 Oct 2001.**

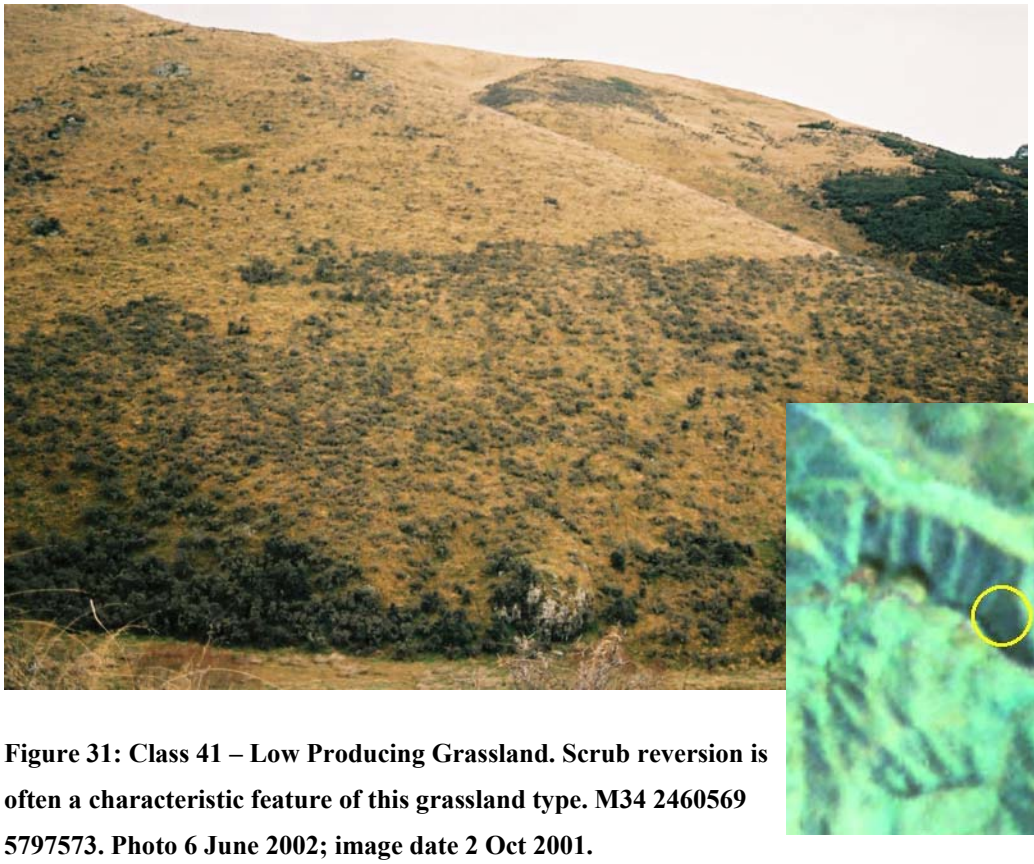


**Figure 31: Class 41 – Low Producing Grassland. Scrub reversion is often a characteristic feature of this grassland type. M34 2460569 5797573. Photo 6 June 2002; image date 2 Oct 2001.**

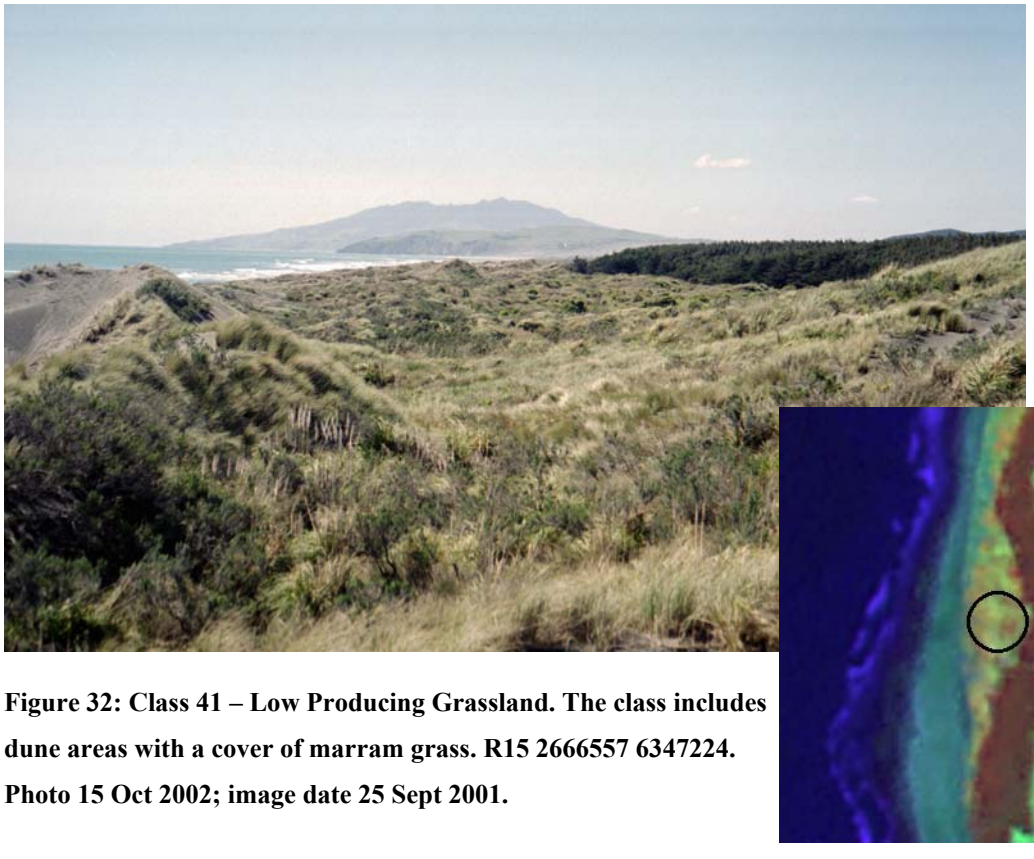


**Figure 32: Class 41 – Low Producing Grassland. The class includes dune areas with a cover of marram grass. R15 2666557 6347224. Photo 15 Oct 2002; image date 25 Sept 2001.**

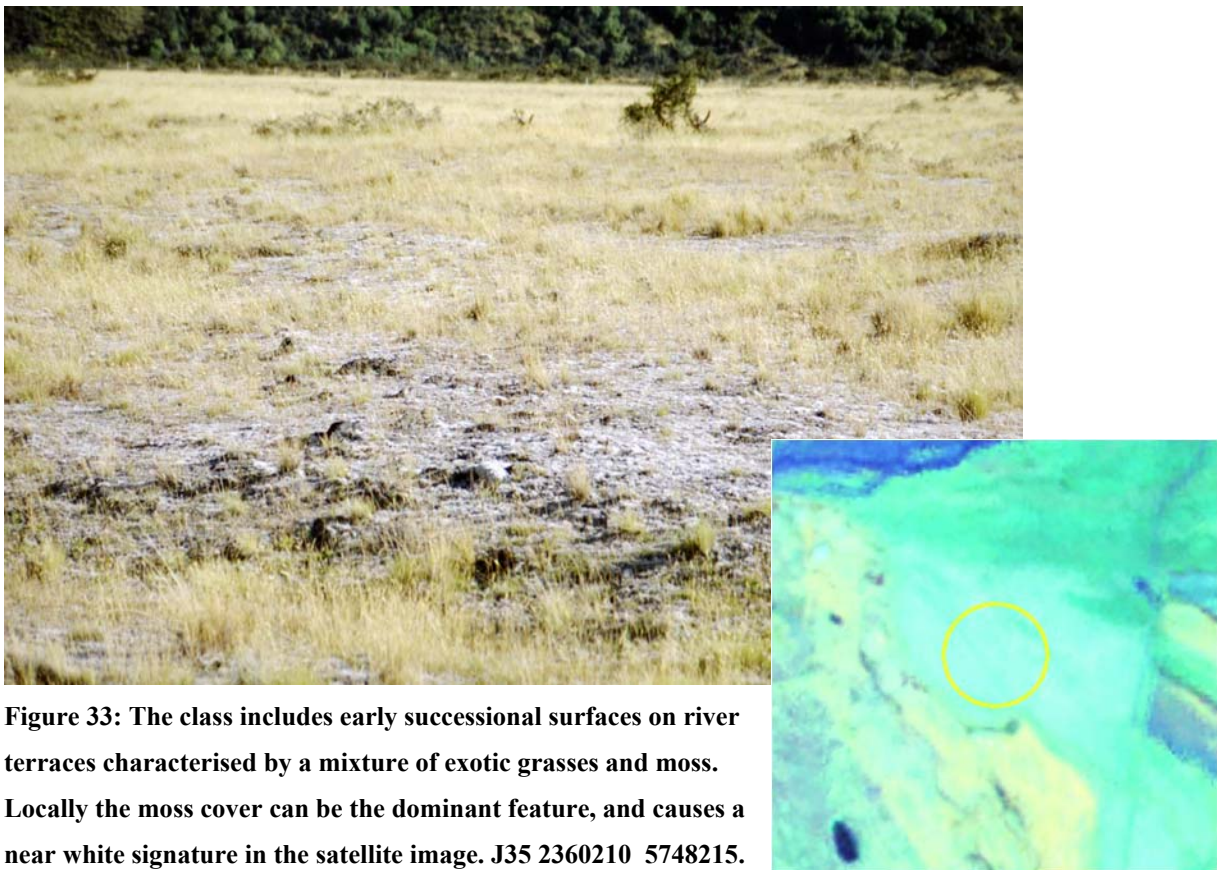


**Figure 33: The class includes early successional surfaces on river terraces characterised by a mixture of exotic grasses and moss. Locally the moss cover can be the dominant feature, and causes a near white signature in the satellite image. J35 2360210 5748215. Photo 24 March 2003, image date 2 Oct 2001.**

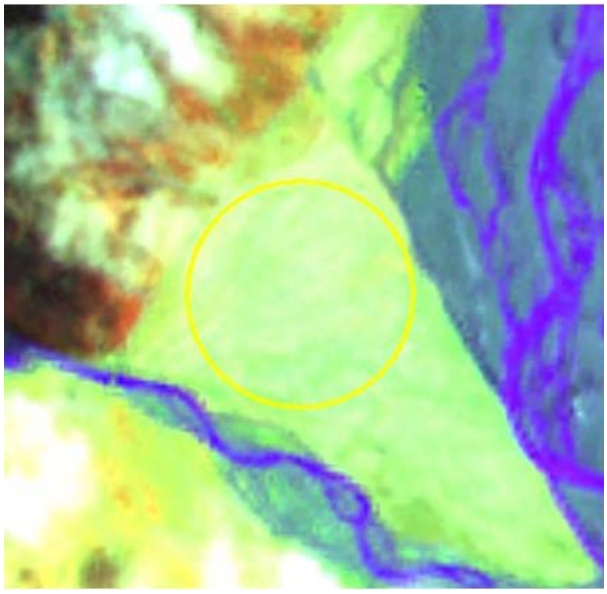


**Figure 34: Riverbed island with dominant moss cover below the Tasman Glacier. H36 2279413 5714838. Image date 29 Jan 2002.**

**Figure 35: Classes 40 and 41 – High Producing Exotic Grassland and Low Producing Grassland. P29 2595142 5928166. Photo 27 September 2002; image date 30 Dec 2001.**

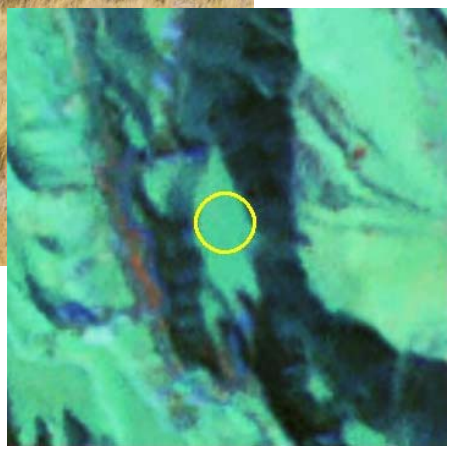
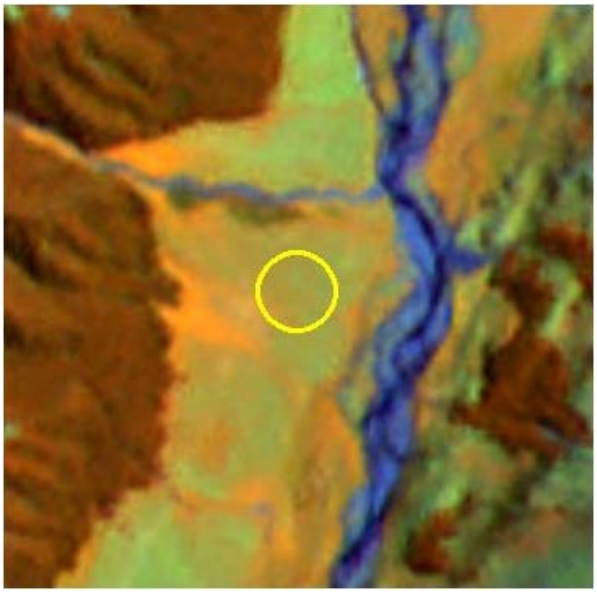
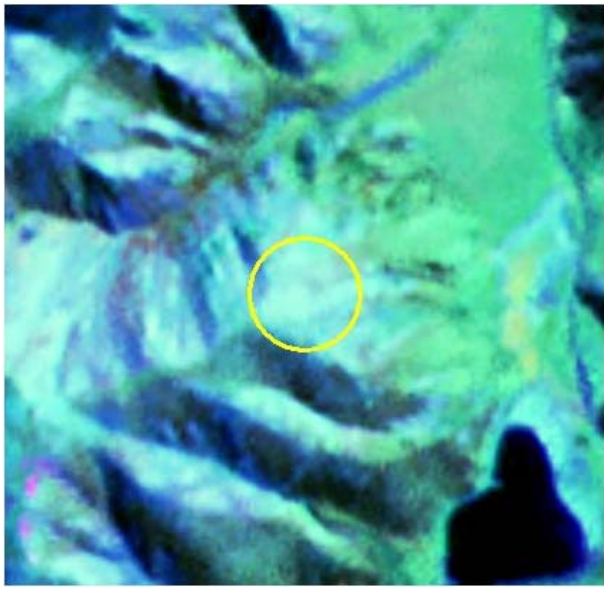


**Figure 36: Class 41 – Low Producing Grassland. The tussocks of native bunch grasses are included in this land cover type. L34 2419429 5780155. Photo 30 May 2002; image date 2 Oct 2001.**



G38 2240251 5660611. Image date 29 Jan 2002.



K35 2404293 5767814 Image date 2 Oct 2001.

**Figure 37: Class 41 – Low Producing Grassland. The signature usually indicates relatively low vigour of the vegetation cover.**

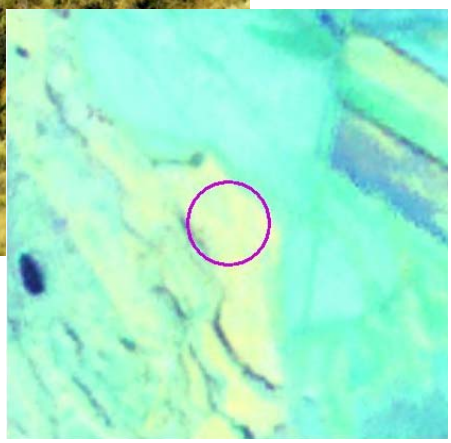
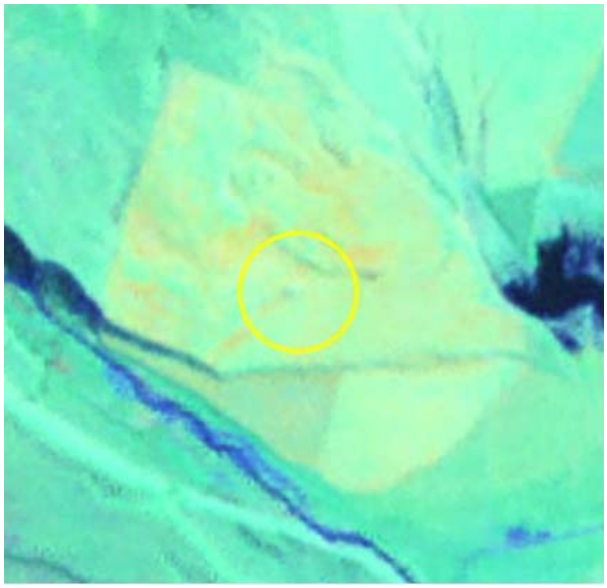
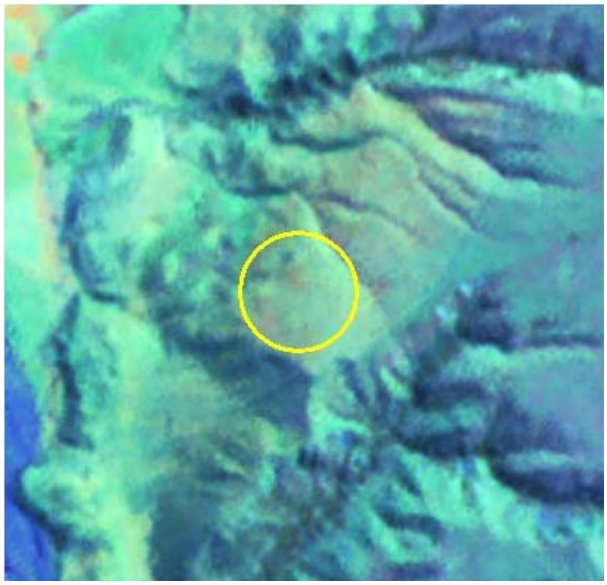


**Figure 38: The class includes areas dominated by *Poa cita*, which can be induced by fertiliser application. The signature of these areas shows a yellow tinge indicating higher productivity. J36 2360490 5747555. Photo 24 March 2003, image date 2 Oct 2001.**



J36 2360878 5735828



J36 2363867 5733724

J36 2364996 5737200

J36 2350585 5730669

**Figure 39: Examples for areas of short tussock grassland induced by farm management and dominated by silver tussock (*Poa cita*). Distinct paddock boundaries are apparent, in particular on the plains. The signature shows a yellow golden tinge indicating higher productivity. Image date 2 Oct 2001.**

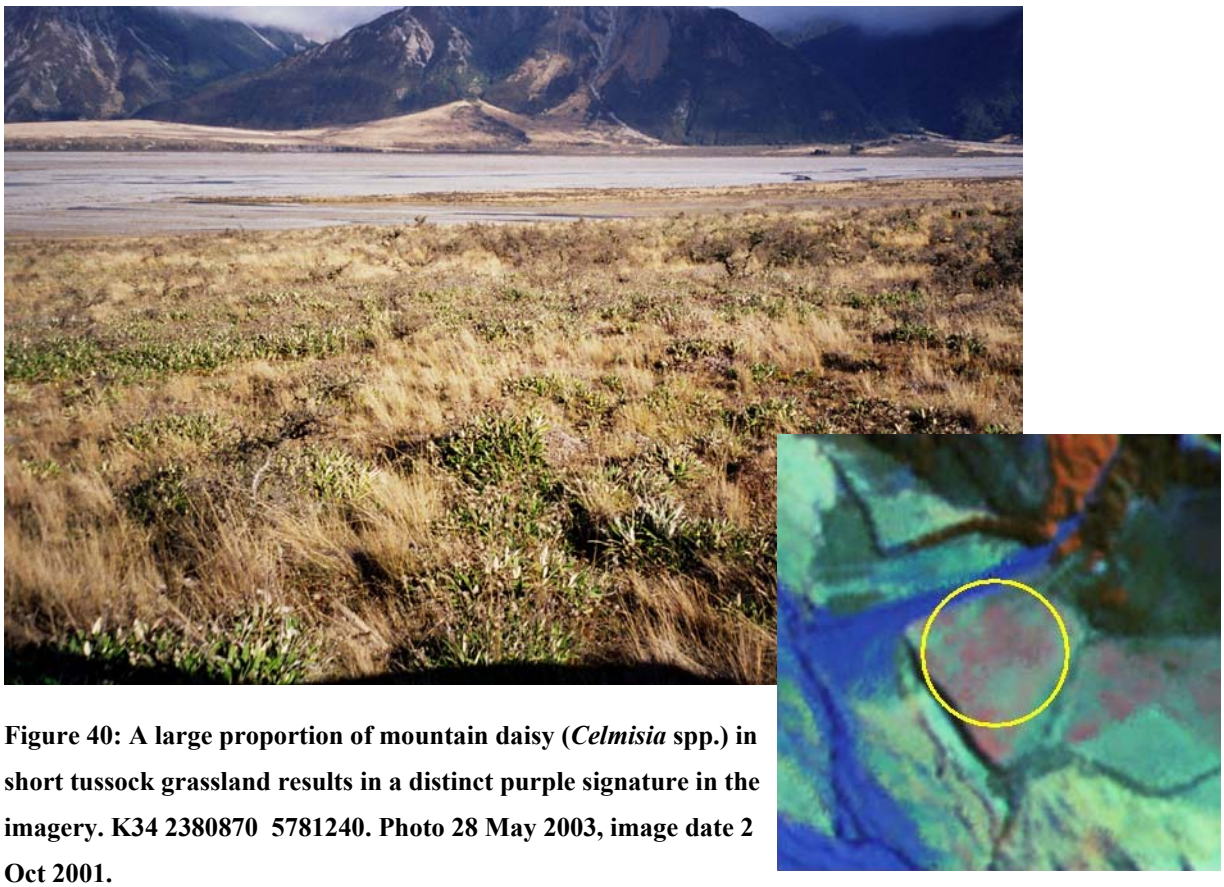


**Figure 40: A large proportion of mountain daisy (*Celmisia* spp.) in short tussock grassland results in a distinct purple signature in the imagery. K34 2380870  5781240. Photo 28 May 2003, image date 2 Oct 2001.**

## 43 Tall Tussock Grassland:

This class is typically found at higher altitudes in the South Island high country with limited presence in the North Island main ranges. Tall Tussock Grassland occurs in areas that have not been subject to intensive farm management. The class is characterised by the presence of *Chionochloa* species, usually accompanied by short tussock grassland species, and a number of herbs, in particular, *Celmisia* species. The structure of this vegetation type varies considerably. In some areas the *Chionochloa* tussocks are very low growing, e.g. where carpet grass (*Chionochloa australis*) is dominant, in other areas they reach up to 150cm in height. Exotic grasses are usually present, especially on pastoral runs that support summer grazing. Paddock size is large reflecting the extensive nature of pastoral activity.

This class also includes areas of red tussock (*Chionochloa rubra*) growing in damp hollows and on boggy ground on terraces and valley floors as part of freshwater wetland systems.

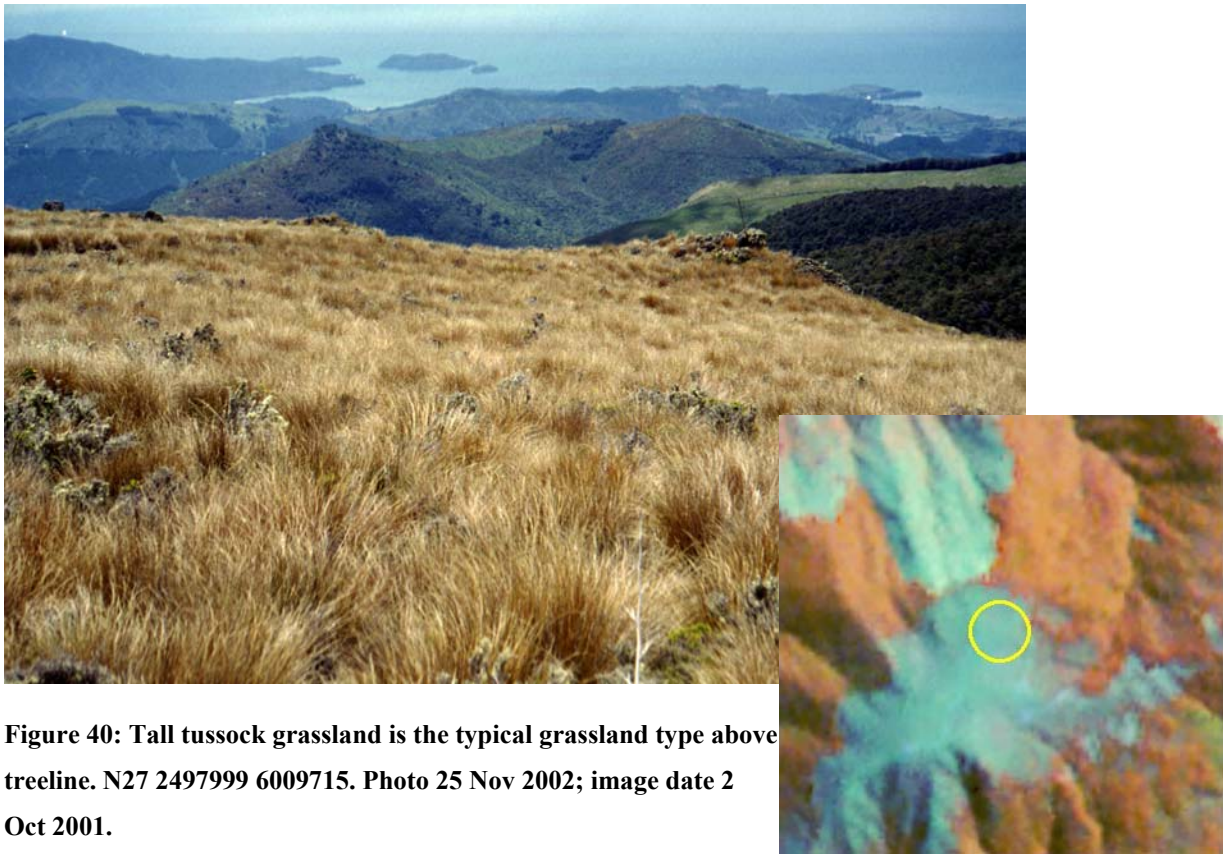


**Figure 40: Tall tussock grassland is the typical grassland type above treeline. N27 2497999 6009715. Photo 25 Nov 2002; image date 2 Oct 2001.**

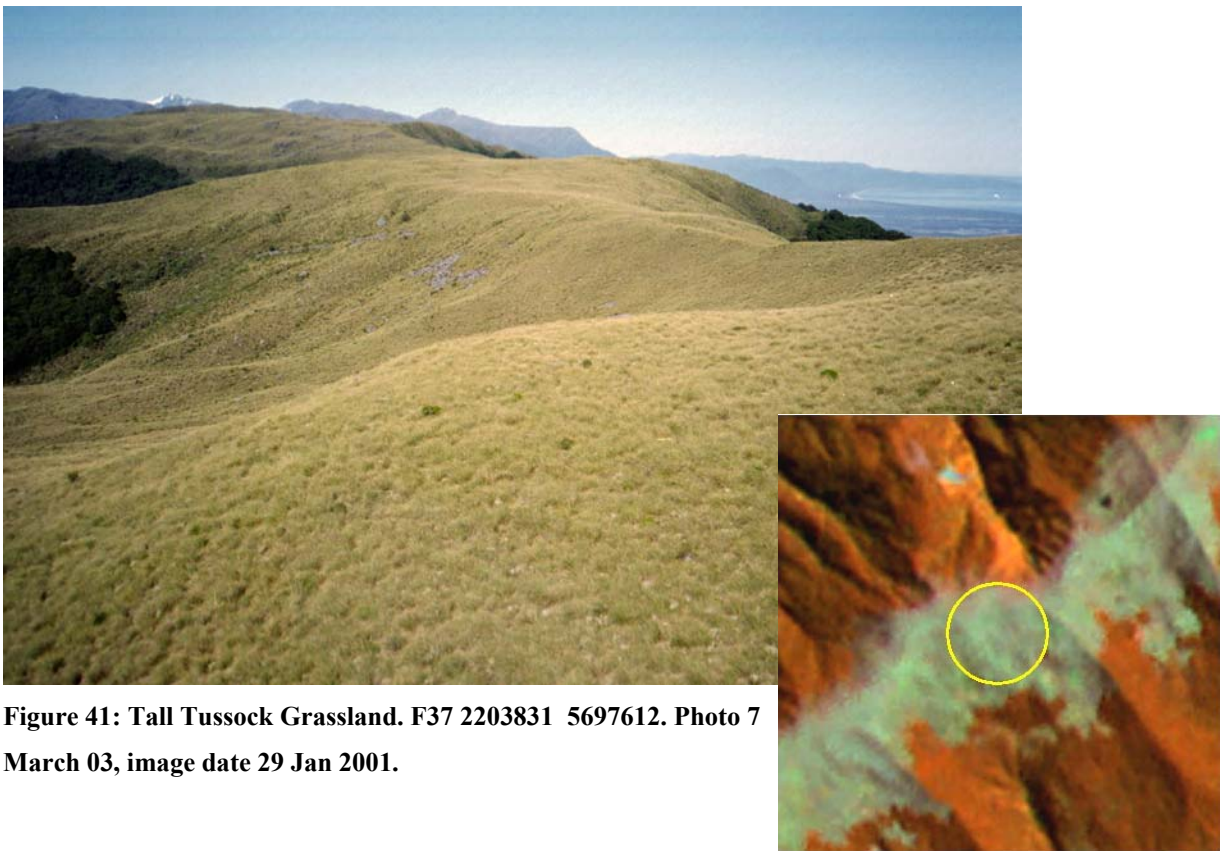


**Figure 41: Tall Tussock Grassland. F37 2203831  5697612. Photo 7 March 03, image date 29 Jan 2001.**

**Figure 42: Tall Tussock Grassland with dominant *Chionochloa crassiuscula*. K33 2390815  5808585. Photo 22 March 2003, image date 2 Oct 2001.**

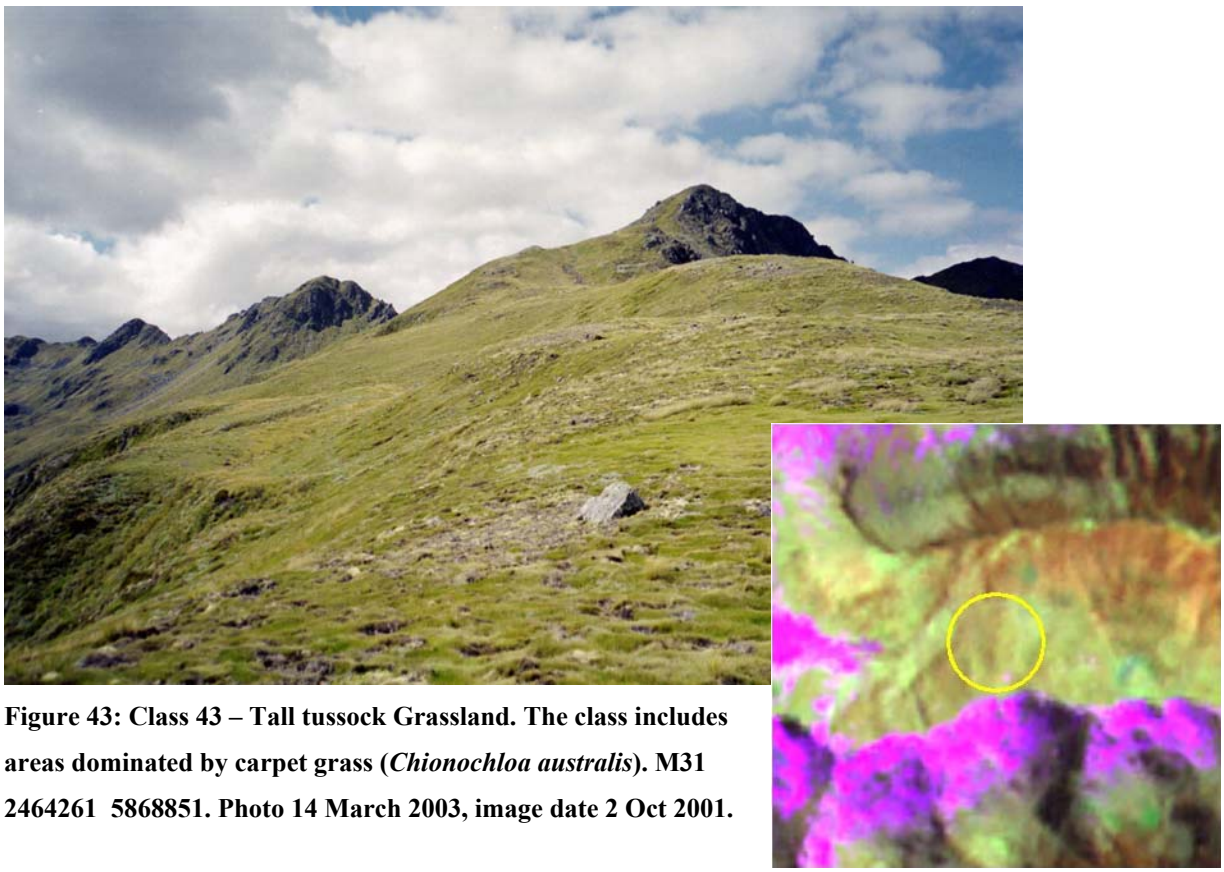


**Figure 43: Class 43 – Tall tussock Grassland. The class includes areas dominated by carpet grass (*Chionochloa australis*). M31 2464261 5868851. Photo 14 March 2003, image date 2 Oct 2001.**

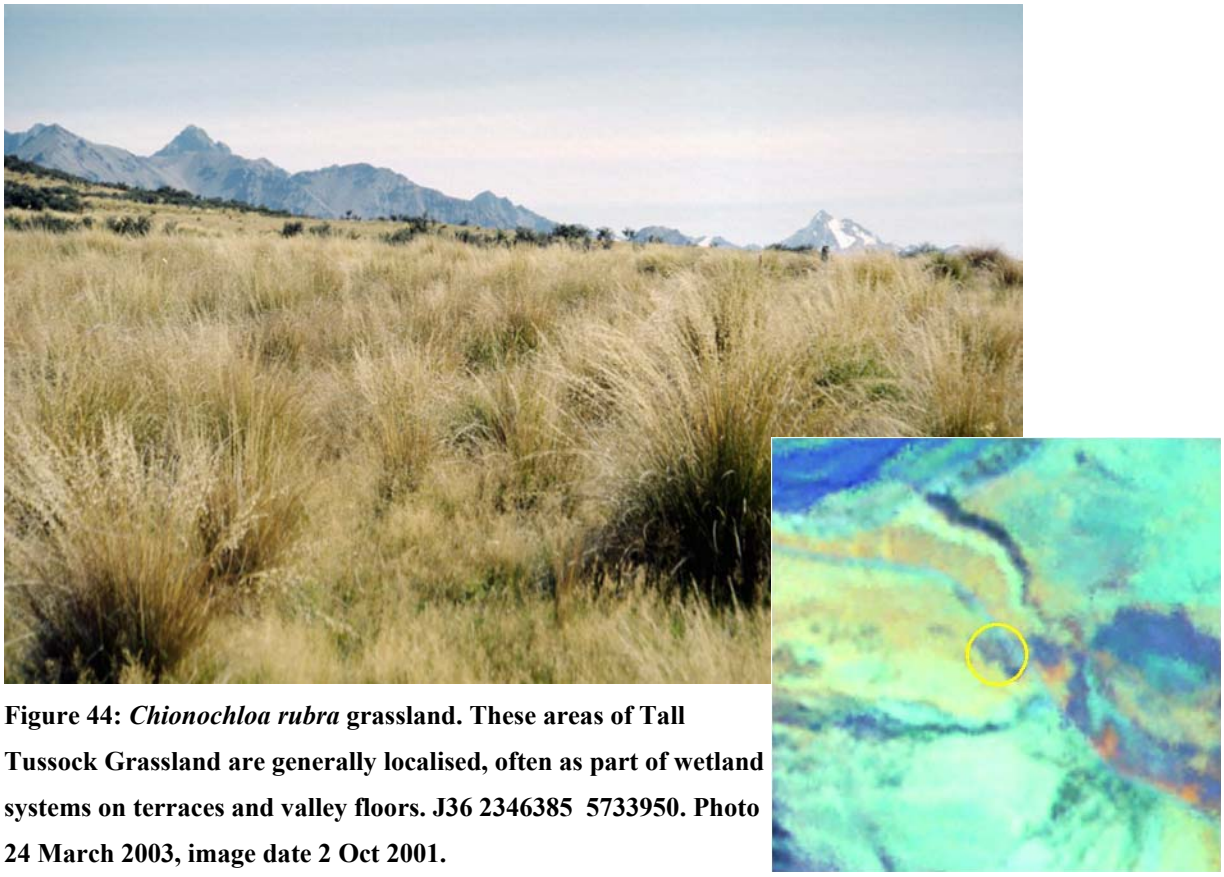
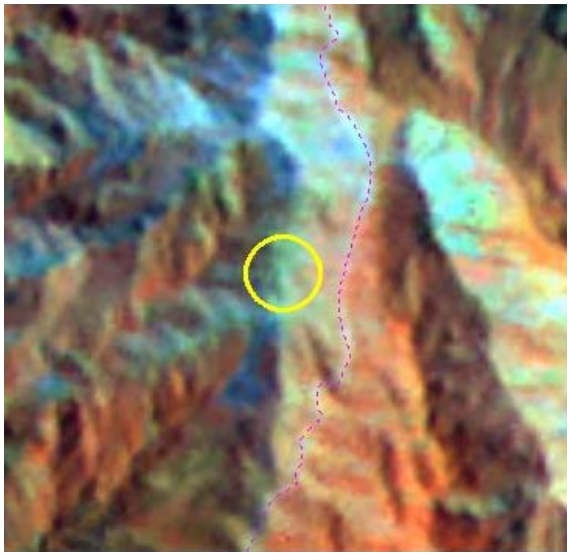
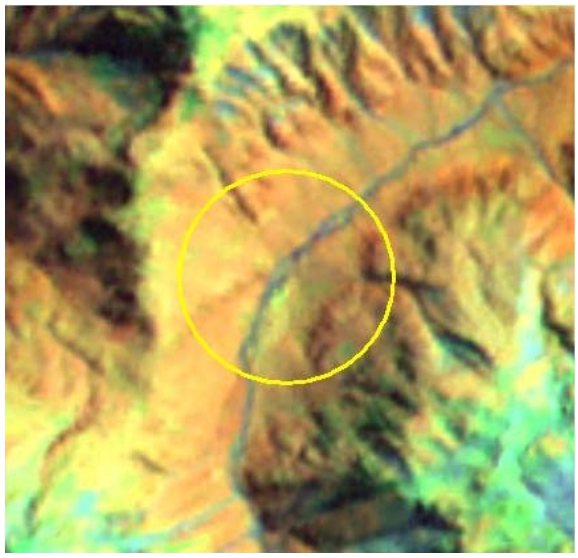


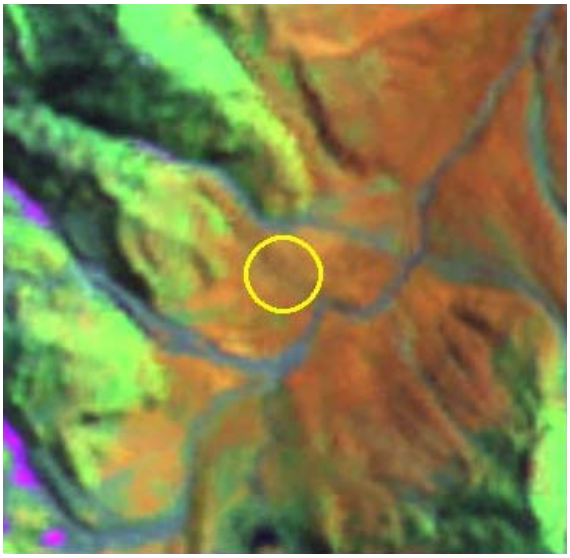
**Figure 44: *Chionochloa rubra* grassland. These areas of Tall Tussock Grassland are generally localised, often as part of wetland systems on terraces and valley floors. J36 2346385 5733950. Photo 24 March 2003, image date 2 Oct 2001.**



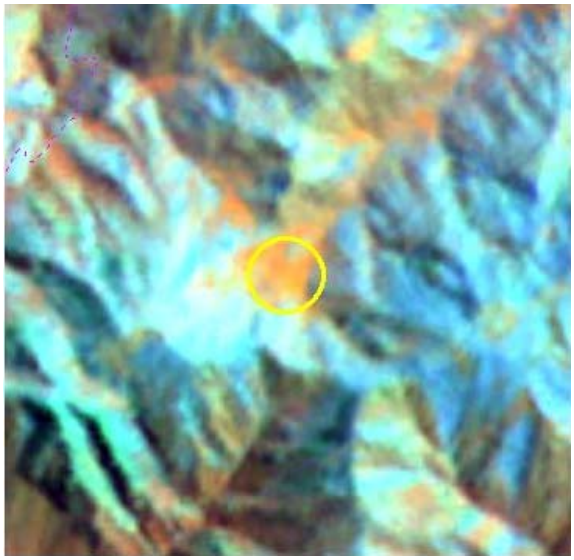
I35 2302093 5749146. Image 14 Feb 2002.



J34 2355274 5790912. Image 14 Feb 2002.



O31 2545015 5874874. Image 30 Dec 2001.

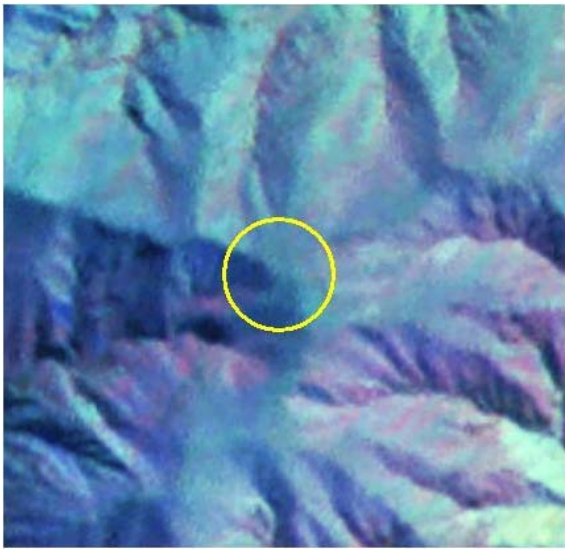


O31 2546822 5876333. Image 30 Dec 2001.

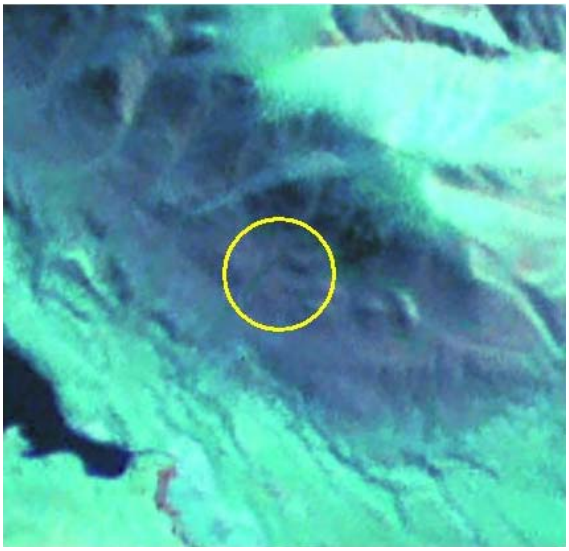
G39 2211445 5640387. Image 29 Jan 2002.

G38 2223166 5652591. Image 29 Jan 2002.

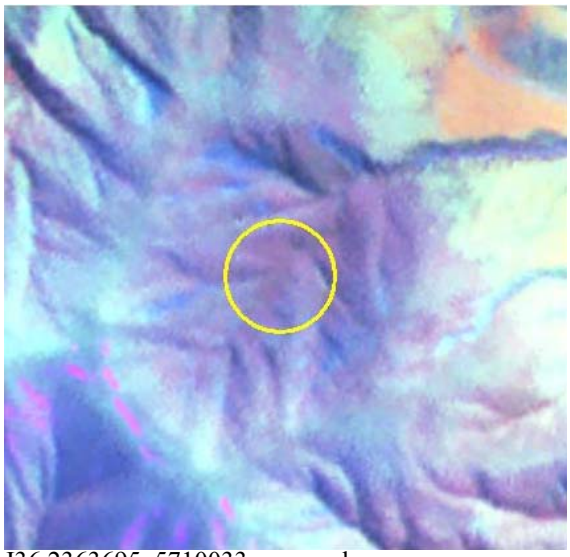
**Figure 45: The signature of Tall Tussock Grassland varies considerably, depending on the density of the vegetation cover and the height of the plants, as well as slope, aspect, and soil moisture levels at the site.**



J36 2367704 5731337, ridge.



J36 2354679 5732630, shady slope



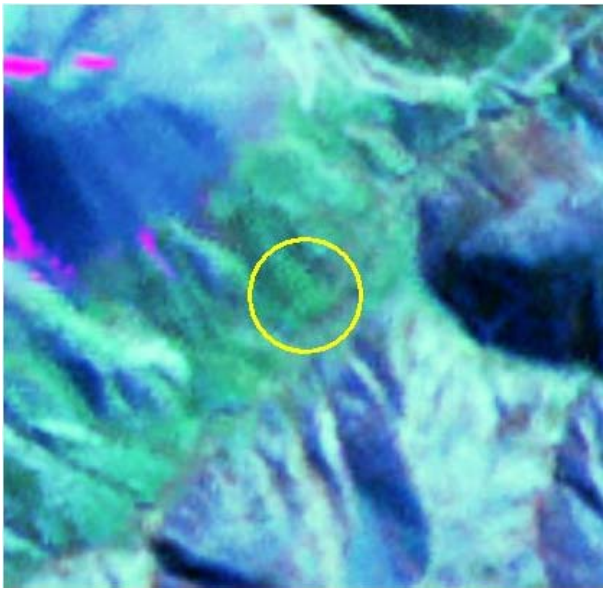
J36 2363695 5710033, sunny slope.

J36 2345873 5737552, glacial terrace.

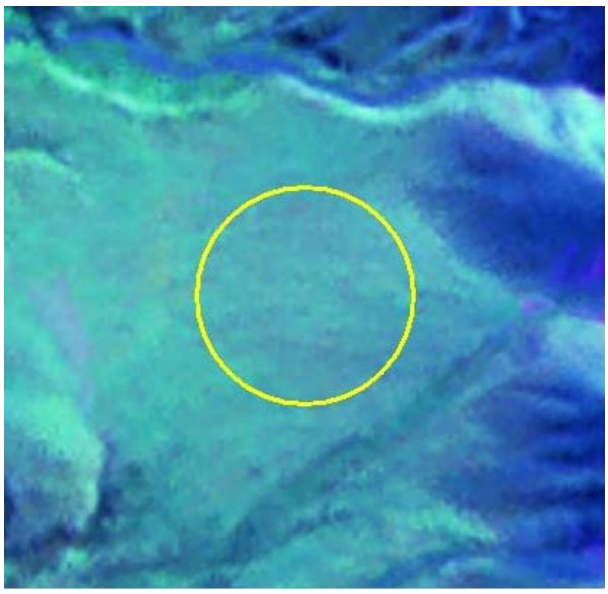
J36 2335585 5734181, sunny slope.

J35 2359447 5752187, glacial terrace.

**Figure 46: Even within a small area (all examples are taken from the area of two NZ260 mapsheets) the signature of Tall Tussock Grassland can vary considerably. Image date 2 Oct 2001.**



K35 2400597 5768161, on ridgeline



K35 2370333 5740847, on glacial terrace

**Figure 47: Signature of Tall Tussock Grassland on K35. Image date 2 Oct 2001.**

## 44 Depleted Grassland:

Areas of very low herbaceous vegetation with grassland/herbfield character. Short tussock grassland species are usually present, but show less than 10% cover. *Hieracium* species and/or exotic grasses are conspicuous, as is the bare ground component. Plant vigour and biomass are significantly lower than in Low Producing Grassland due to soil nutrient loss through repeated burning and overgrazing. The class is found in areas with a known history of livestock grazing. Areas of Depleted Tussock Grassland are particularly prominent in the dryer parts of the South Island high country, such as the Mackenzie Basin and Central Otago. The signature of Depleted Grassland in the satellite imagery is very variable. Characteristic is a blue hue reflecting the high bare ground component.

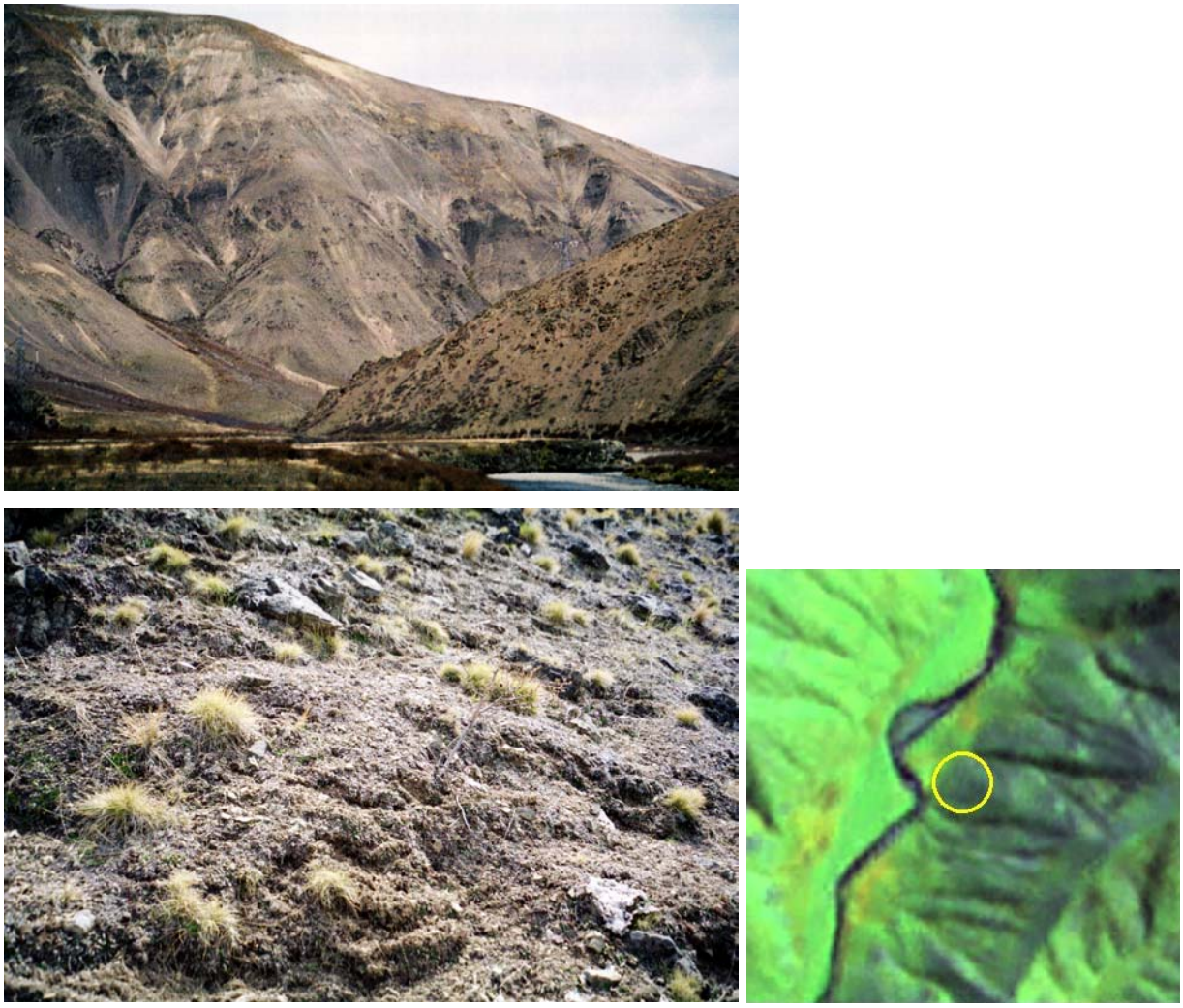


**Figure 48: Class 44 – Depleted Tussock Grassland. N30/31, Acheron Valley. Photos 10 Nov 2002; image date 2 Oct 2001.**

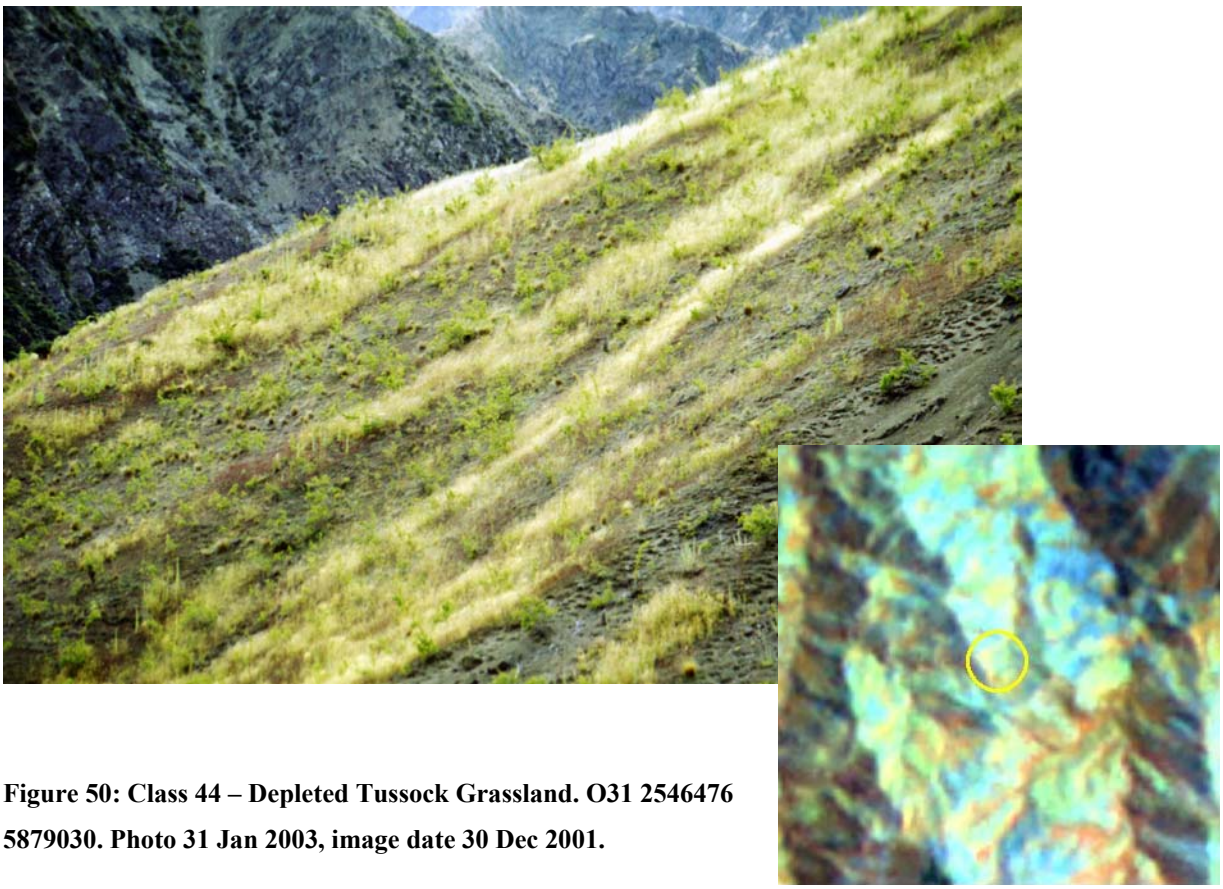


**Figure 50: Class 44 – Depleted Tussock Grassland. O31 2546476 5879030. Photo 31 Jan 2003, image date 30 Dec 2001.**

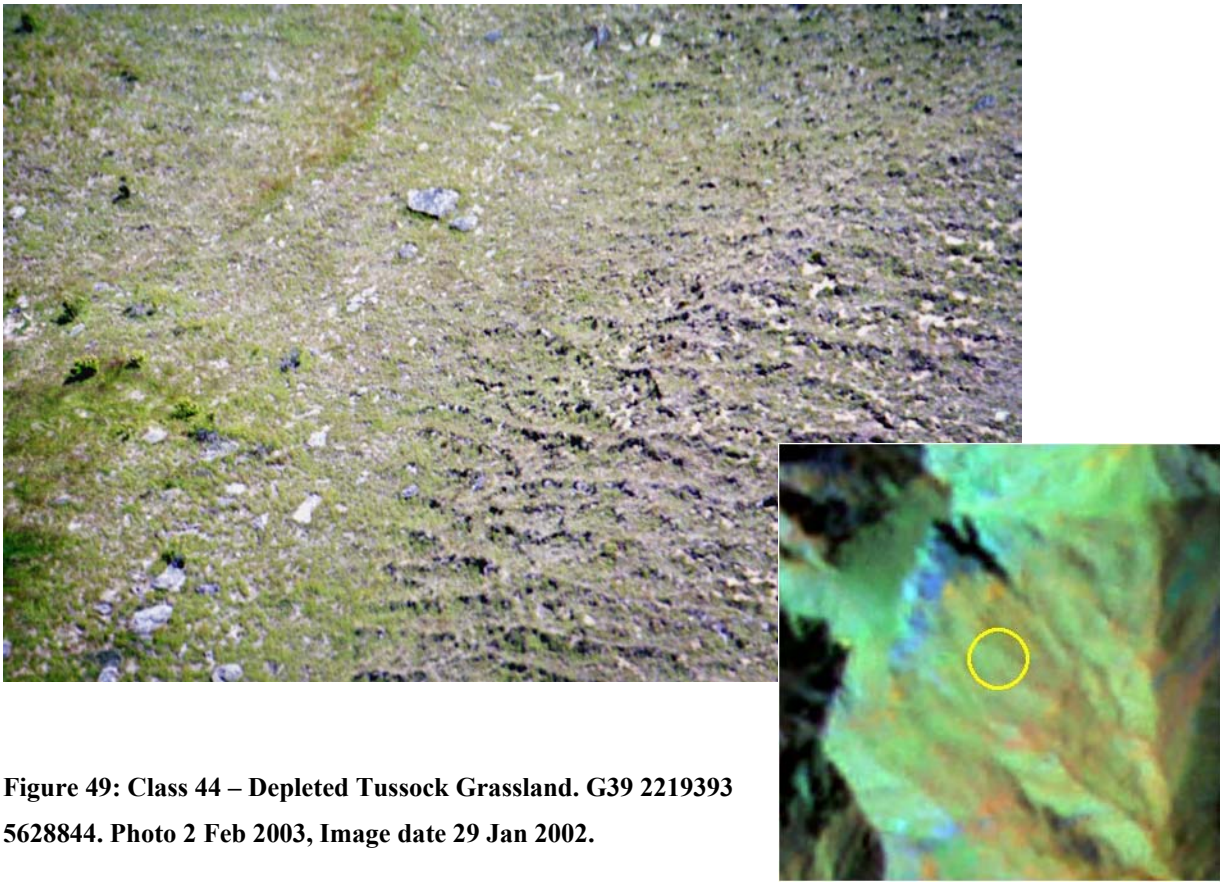
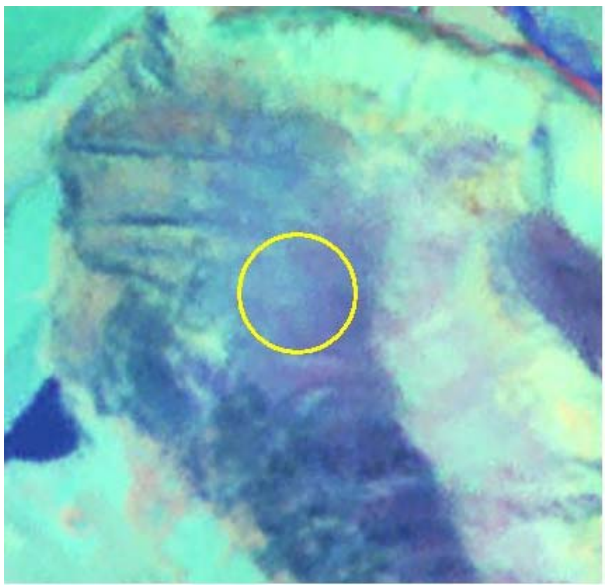


**Figure 49: Class 44 – Depleted Tussock Grassland. G39 2219393 5628844. Photo 2 Feb 2003, Image date 29 Jan 2002.**



J36 2362398 5729565, in hill country.

J36 2360865 5733888, on the plains.

**Figure 50: The signature of Depleted Grassland in the Upper Rangitata Valley. Image date 2 Oct 2001.**

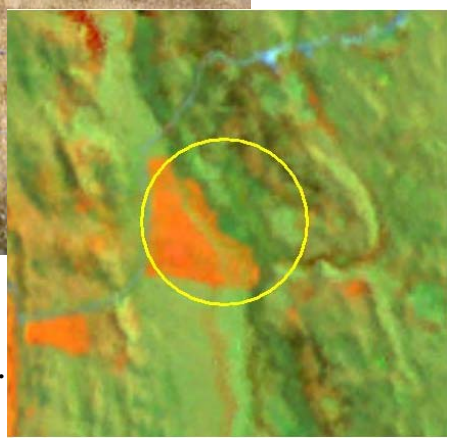


**Figure 51: Transition from High Producing Exotic Grassland on flat terrain to Depleted Grassland on slopes in the Mackenzie Basin. I37 2291354 5687420. Photo 12 Feb 2003, image date 29 Jan 2002.**

**Figure 52: An area of Class 40 – High Producing Exotic Grassland adjacent to an area of Class 44 – Depleted Grassland in the Mackenzie Basin. H39 2270967  5643827. Photo 7 March 2003, image date 29 Jan 2002.**

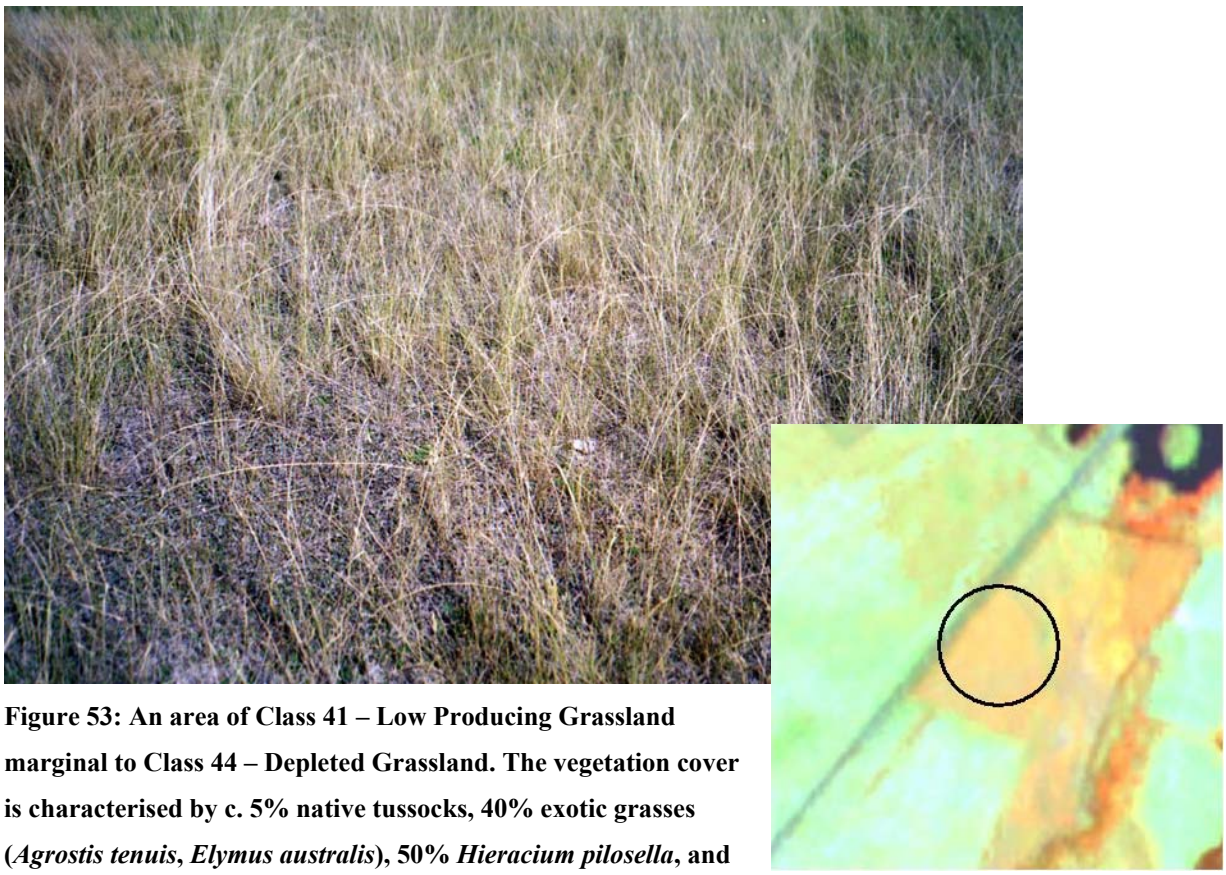


**Figure 53: An area of Class 41 – Low Producing Grassland marginal to Class 44 – Depleted Grassland. The vegetation cover is characterised by c. 5% native tussocks, 40% exotic grasses (*Agrostis tenuis*, *Elymus australis*), 50% *Hieracium pilosella*, and 1% bare ground. H38 2275767 5651333. Photo 7 March 2003, image date 29 Jan 2002.**

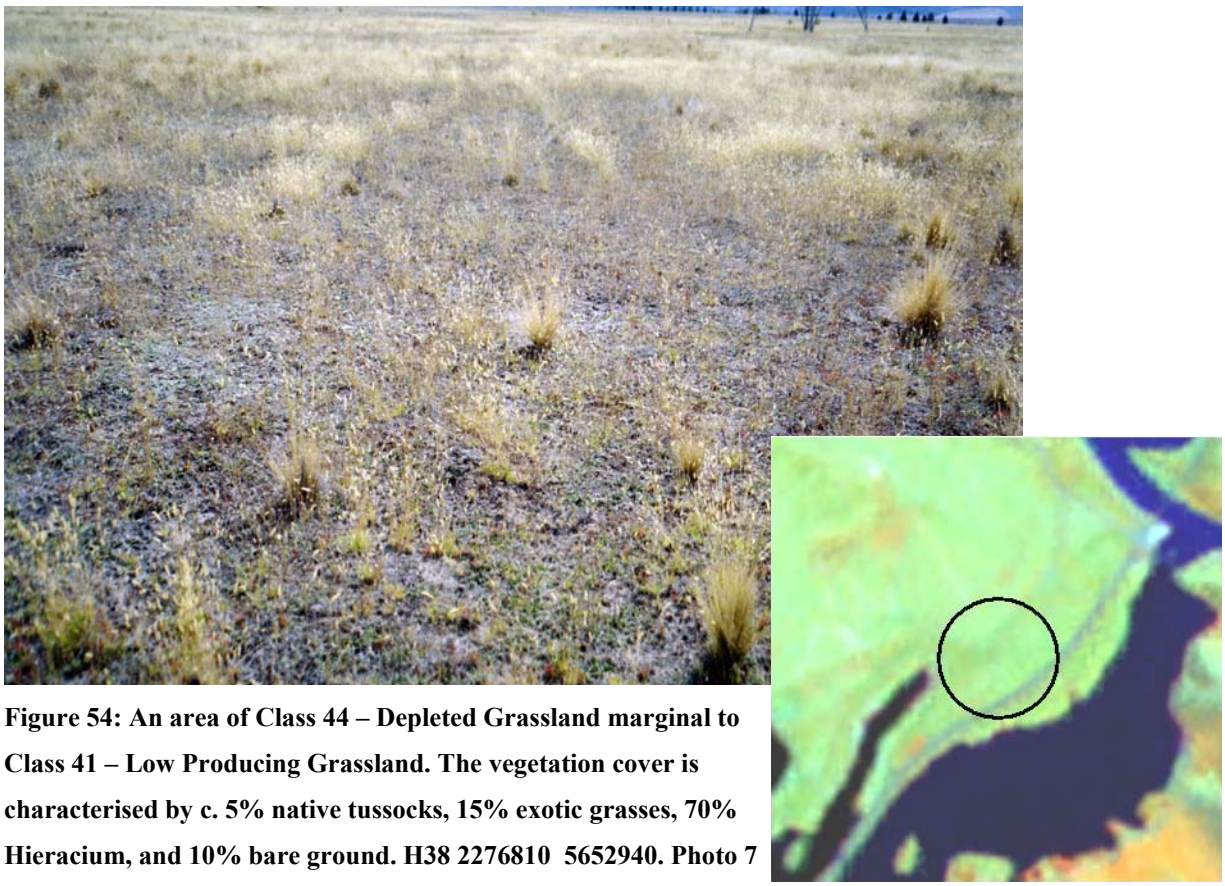


**Figure 54: An area of Class 44 – Depleted Grassland marginal to Class 41 – Low Producing Grassland. The vegetation cover is characterised by c. 5% native tussocks, 15% exotic grasses, 70% Hieracium, and 10% bare ground. H38 2276810 5652940. Photo 7 March 2003, image date 29 Jan 2002.**

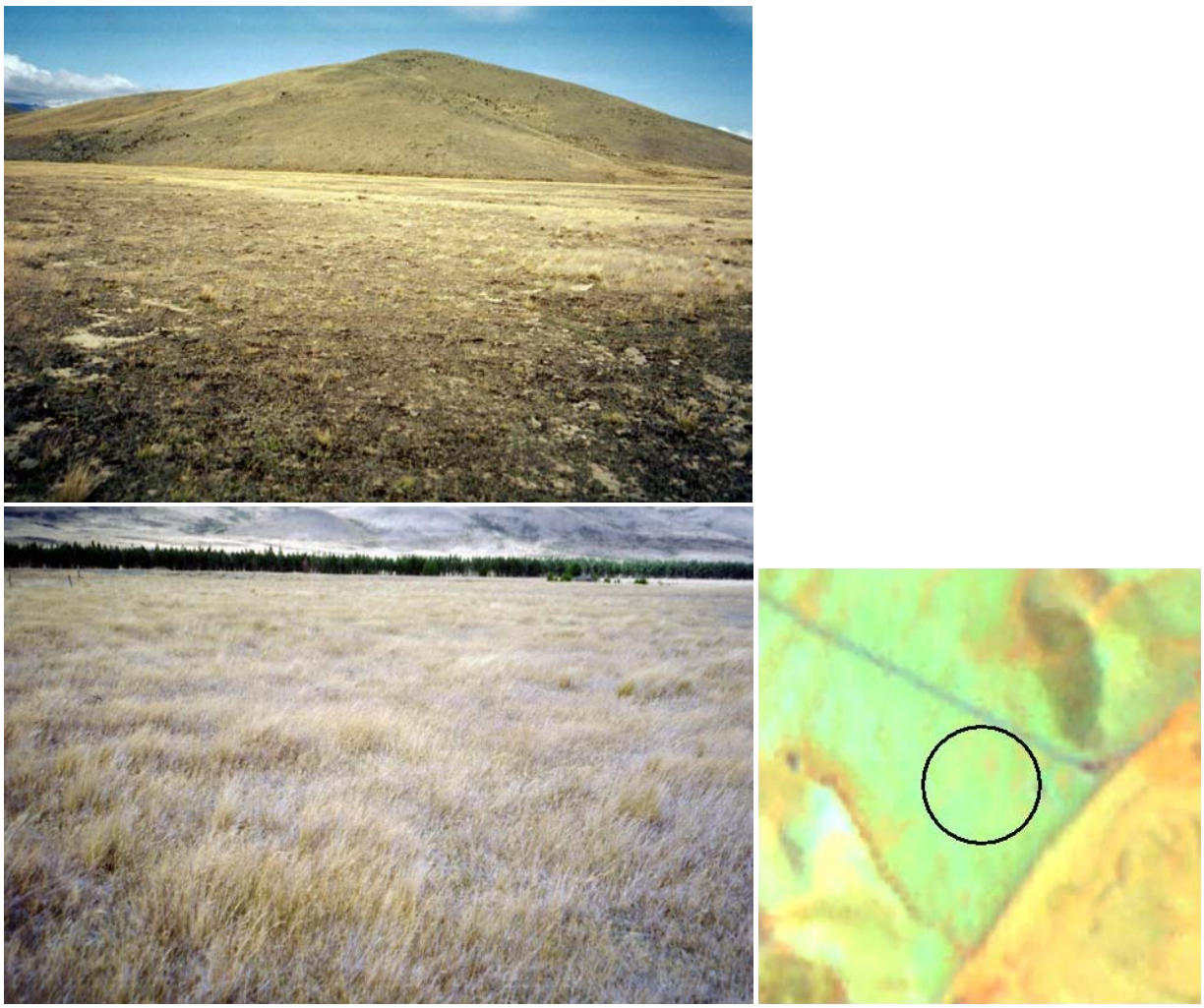


**Figure 55: Top: Class 44 – Depleted Grassland with cover of c. 5% native tussocks, 5% exotic grasses, 80% *Hieracium pilosella*, and 10% bare ground. Bottom: Class 41 – Low Producing Grassland with cover of c. 20% native tussocks, 80% exotic grasses (mainly browntop, *Agrostis tenuis*), 5% *Hieracium pilosella*, and 1% bare ground. Many areas in the Mackenzie Basin form a mosaic of these two classes. In the Land Cover Database they are mapped according to the dominant signature. The area in this example has been classified as Class 44 – Depleted Grassland. I38 2314848 5676073. Photos 7 March 2003, image date 29 Jan 2002.**

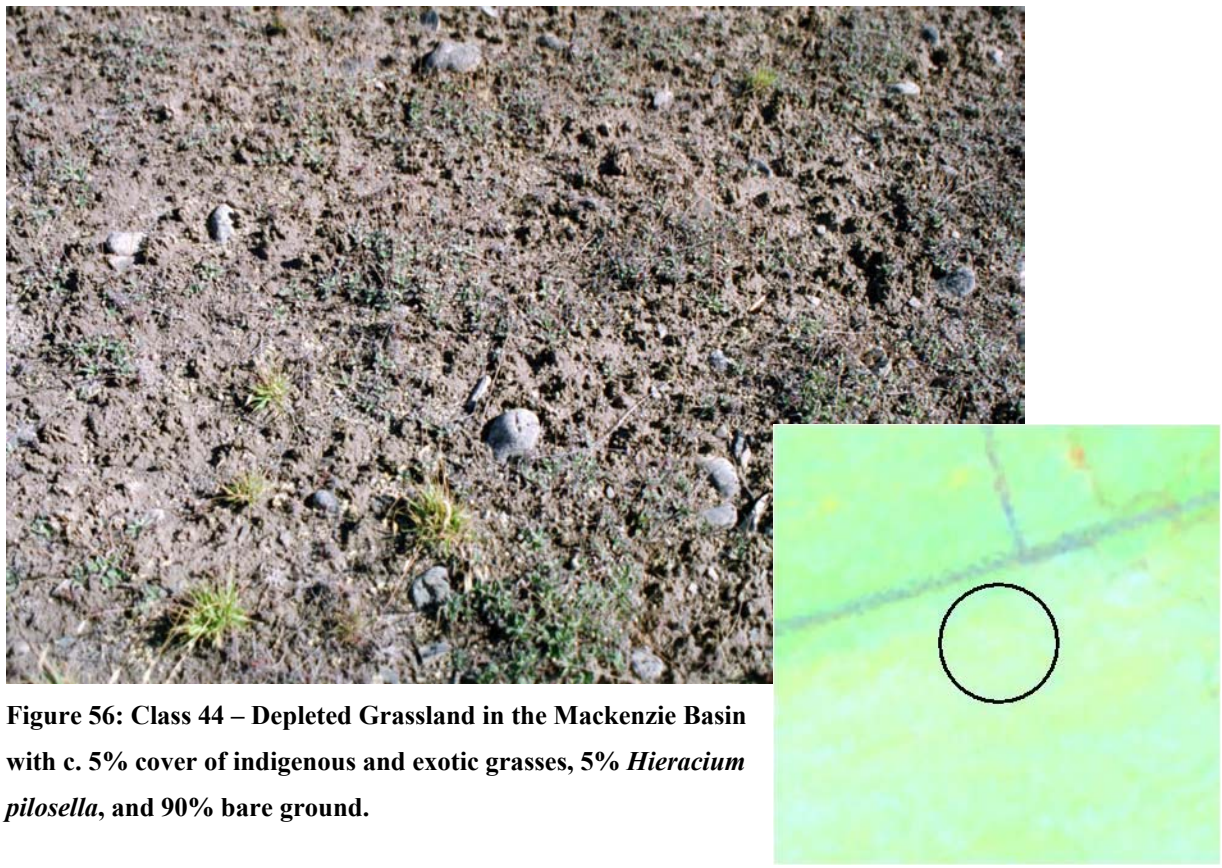


**Figure 56: Class 44 – Depleted Grassland in the Mackenzie Basin with c. 5% cover of indigenous and exotic grasses, 5% *Hieracium pilosella*, and 90% bare ground.**

## 45 Herbaceous Freshwater Vegetation:

Areas dominated by herbaceous aquatic vegetation as a component of freshwater wetlands, i.e. the plants emerge over freshwater or grow in freshwater saturated soils. The vegetation is dominated by sedges (*Cyperaceae*), rushes (*Juncaceae*), or tall erect herbs from other families (*Poaceae*, *Restionaceae*, *Typhaceae* ). The class also includes areas of low-growing dicotyledon herbs and areas of sphagnum moss. Areas of red tussock are excluded, as they are mapped under Tall Tussock Grassland (Class 43). Areas of Herbaceous Freshwater Vegetation can be permanently or periodically wet (ephemeral wetlands). The mapped area reflects the extent evident in the 2001 / 2002 satellite imagery

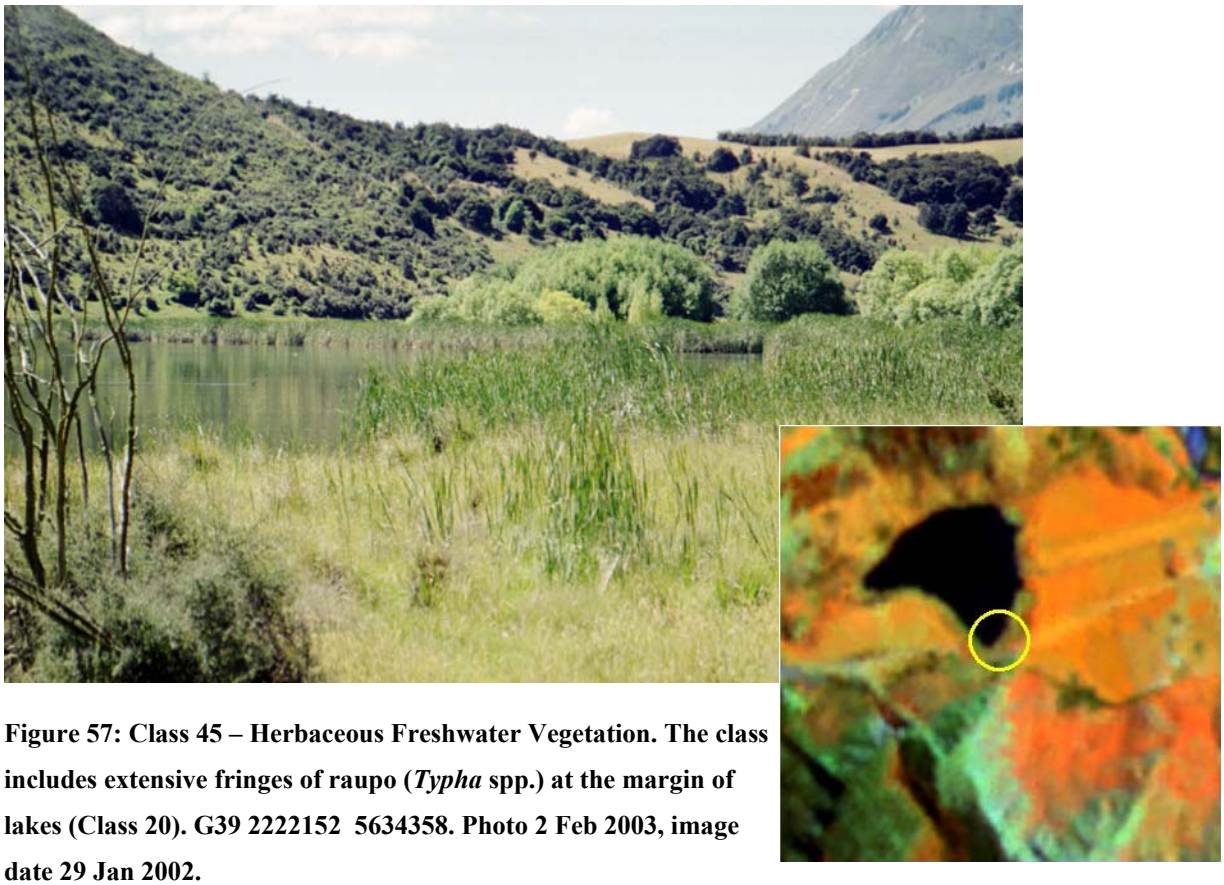


**Figure 57: Class 45 – Herbaceous Freshwater Vegetation. The class includes extensive fringes of raupo (*Typha* spp.) at the margin of lakes (Class 20). G39 2222152 5634358. Photo 2 Feb 2003, image date 29 Jan 2002.**

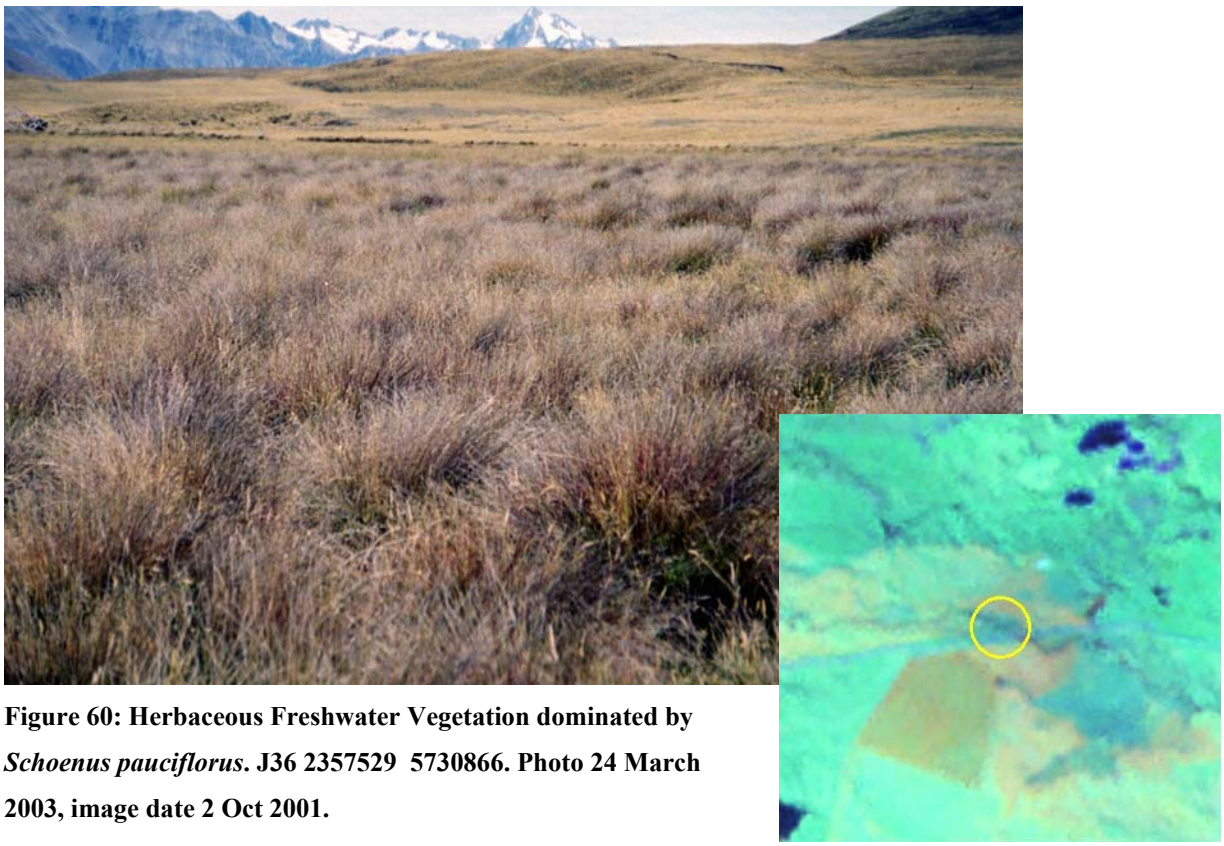


**Figure 60: Herbaceous Freshwater Vegetation dominated by *Schoenus pauciflorus*. J36 2357529 5730866. Photo 24 March 2003, image date 2 Oct 2001.**

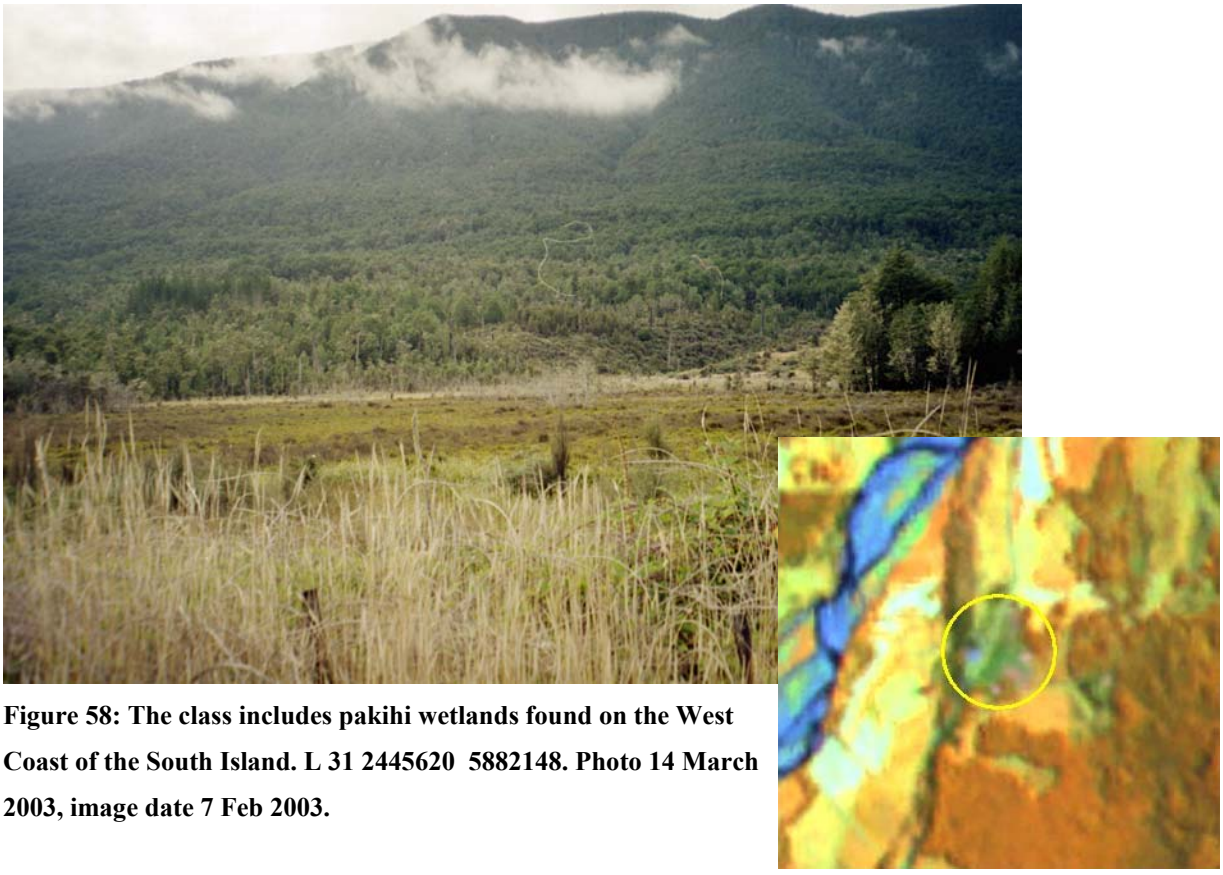


**Figure 58: The class includes pakihi wetlands found on the West Coast of the South Island. L 31 2445620 5882148. Photo 14 March 2003, image date 7 Feb 2003.**

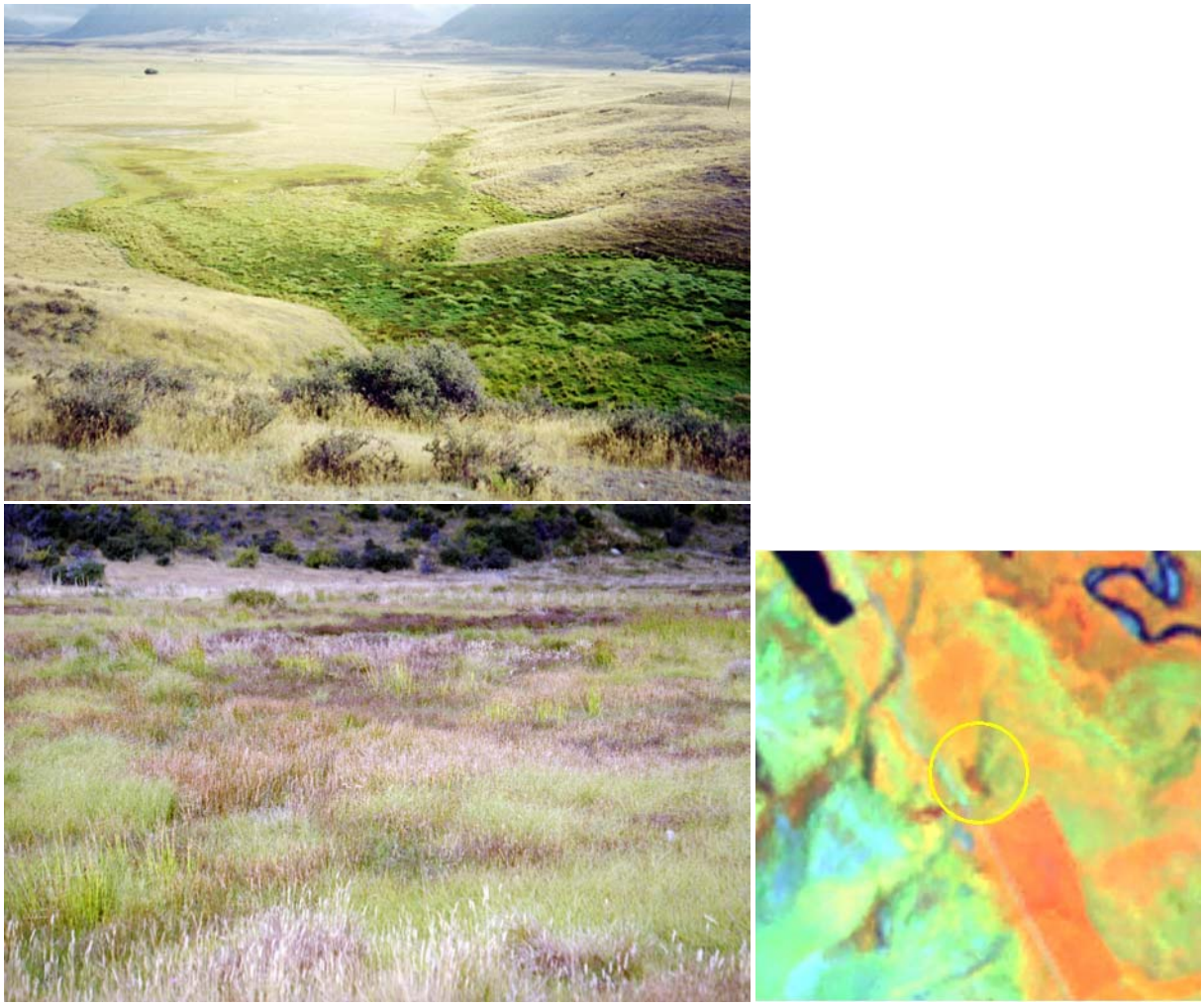
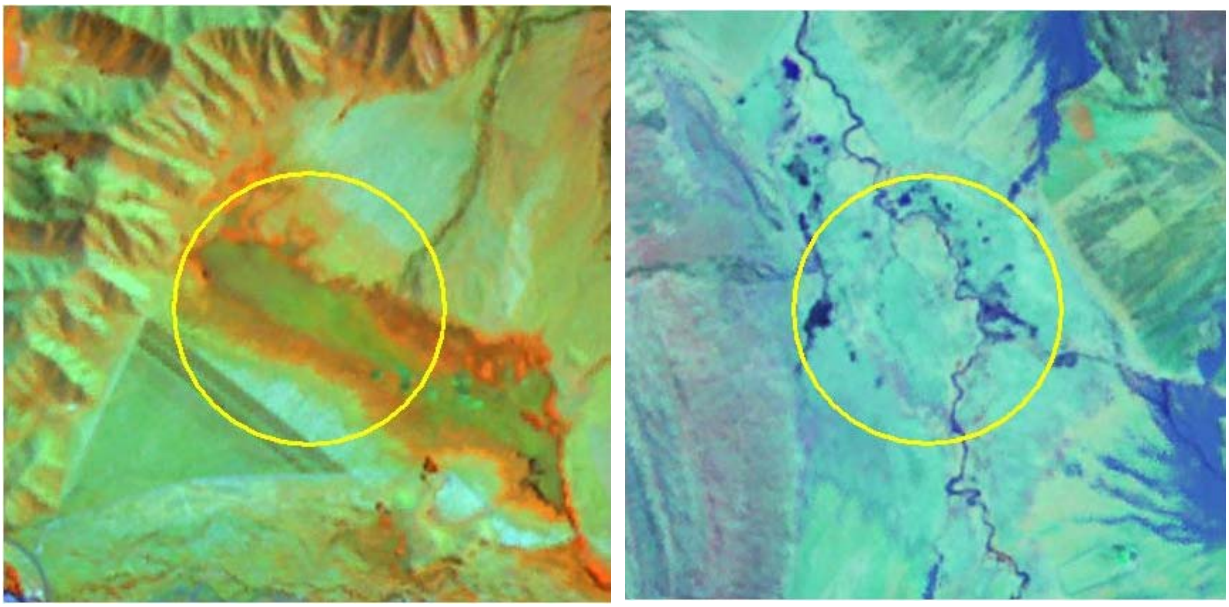


**Figure 59: Herbaceous Freshwater Vegetation dominated by *Carex sinclairii* and *Eleocharis acuta*. G39 2243098 5640642. Photo 11 March 2003, image date 29 Jan 2001.**



H39 2272277 5635566. Image date 29 Jan 2002. J36 2361452 5753579. Image date 2 Oct 2001.

**Figure 60: The signature of Class 45 – Herbaceous Freshwater Vegetation varies greatly depending on vegetation cover and moisture content.**

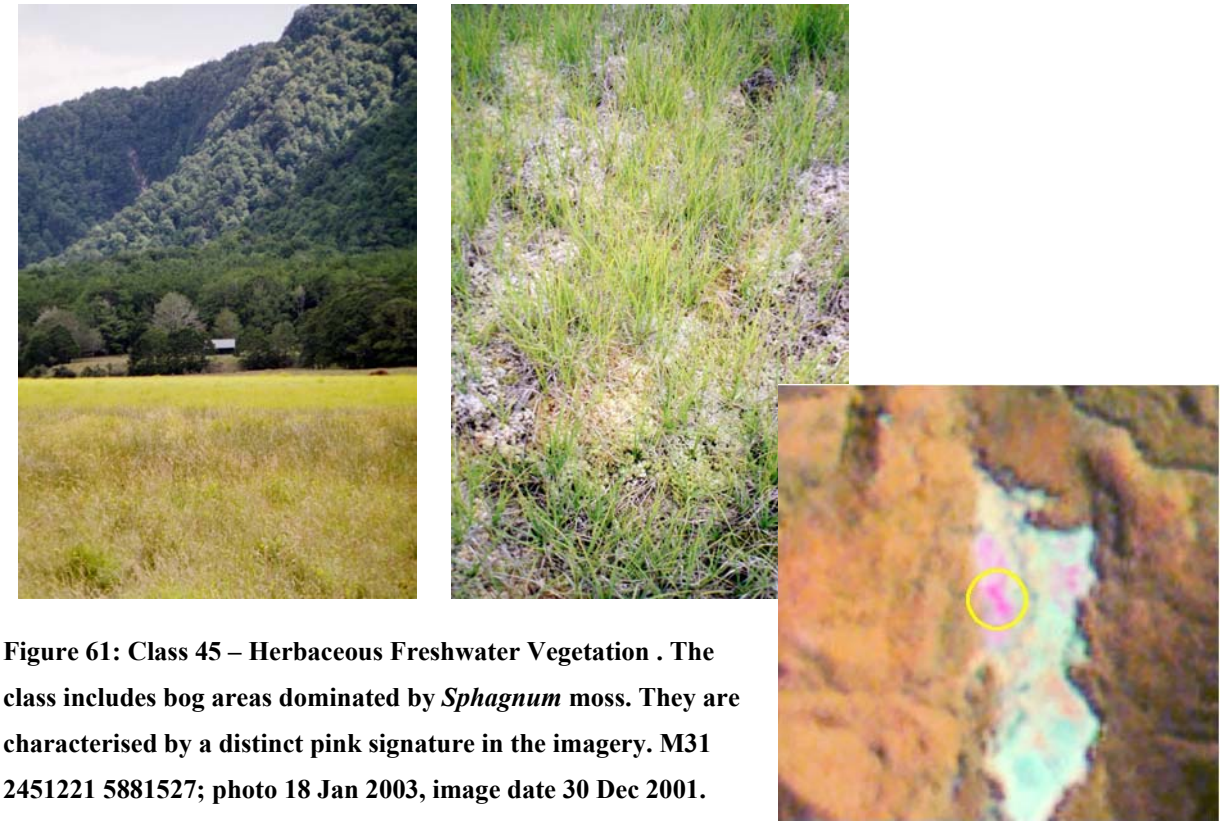


**Figure 61: Class 45 – Herbaceous Freshwater Vegetation . The class includes bog areas dominated by *Sphagnum* moss. They are characterised by a distinct pink signature in the imagery. M31 2451221 5881527; photo 18 Jan 2003, image date 30 Dec 2001.**

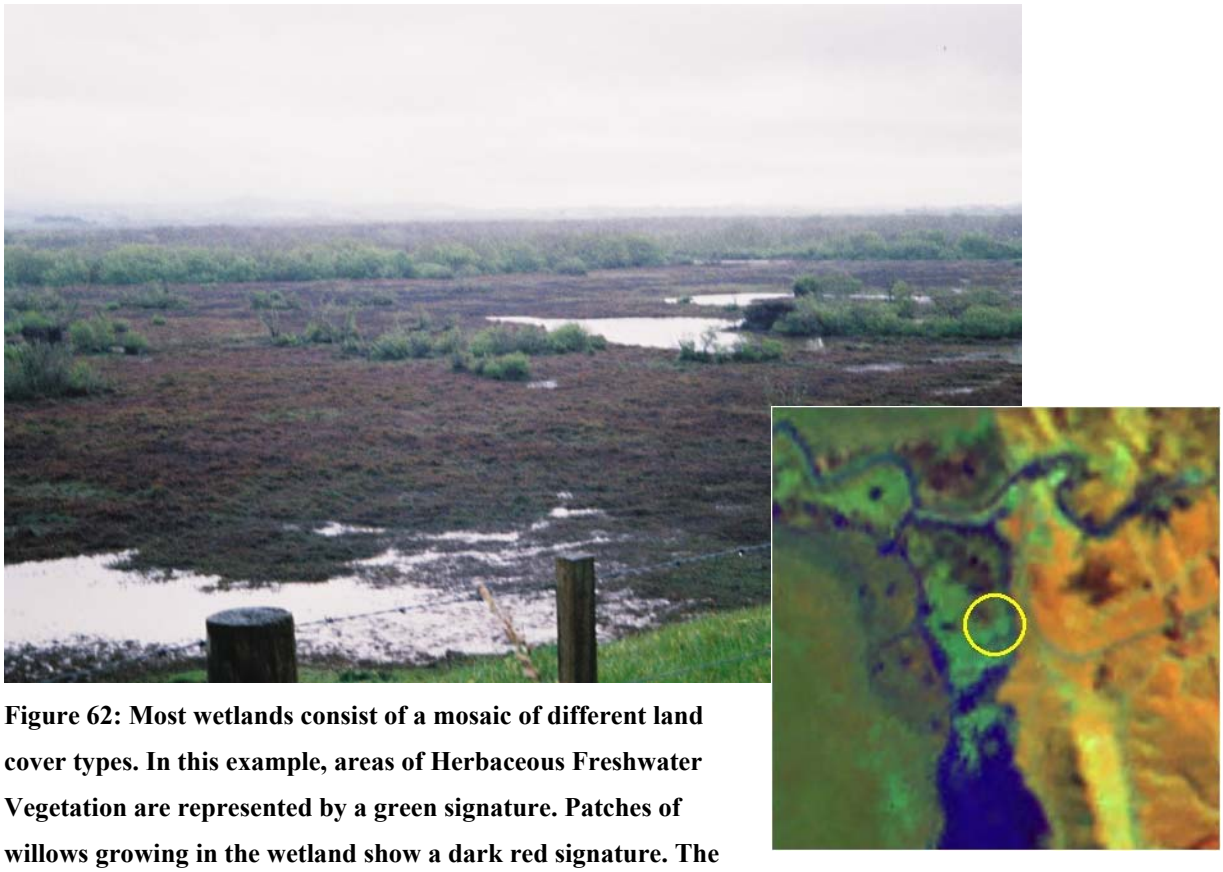


**Figure 62: Most wetlands consist of a mosaic of different land cover types. In this example, areas of Herbaceous Freshwater Vegetation are represented by a green signature. Patches of willows growing in the wetland show a dark red signature. The latter are assigned to Class 68 – Deciduous Hardwoods, if they reach the MMU of 1 ha. S13 2703670  6425592. Photo date; image 25 Sept 2001.**

## 46 Herbaceous Saline Vegetation:

Areas dominated by herbaceous aquatic vegetation as a component of estuarine or coastal wetlands, i.e. the plants emerge over saline or brackish water or grow in saltwater saturated soils. Most areas of Herbaceous Saline Vegetation are subject to tidal changes in water level. The vegetation is dominated by salt-tolerant plants, such as *Schoenoplectus spp.*, *Apodasmia similis*, or glasswort (*Sarcocornia quinqueflora*).

**Figure 63: Class 46 – Herbaceous Saline Vegetation. Q29 2607780 5943931. Photo 27 Sept 2002; image date: 30 Dec 2001.**

**Figure 64: Class 46 - Herbaceous Saline Vegetation . N27 2523472 5987771. Photo 13 Nov 2002; image date 2 Oct 2001.**

## 47 Flaxland:

Areas dominated by lowland flax (*Phormium tenax*). Sites are usually moist and often represent parts of wetland systems.

(Note: In LCDB 1, stands of flax outside wetland systems were mapped in the scrub class. Where flax mapped in LCDB 2 corresponds with scrub in LCDB 1, it will be removed from the LCDB 1 scrub class and reassigned to the most appropriate LCDB 1 wetland class, to ensure compatibility between LCDB 1 and 2.)

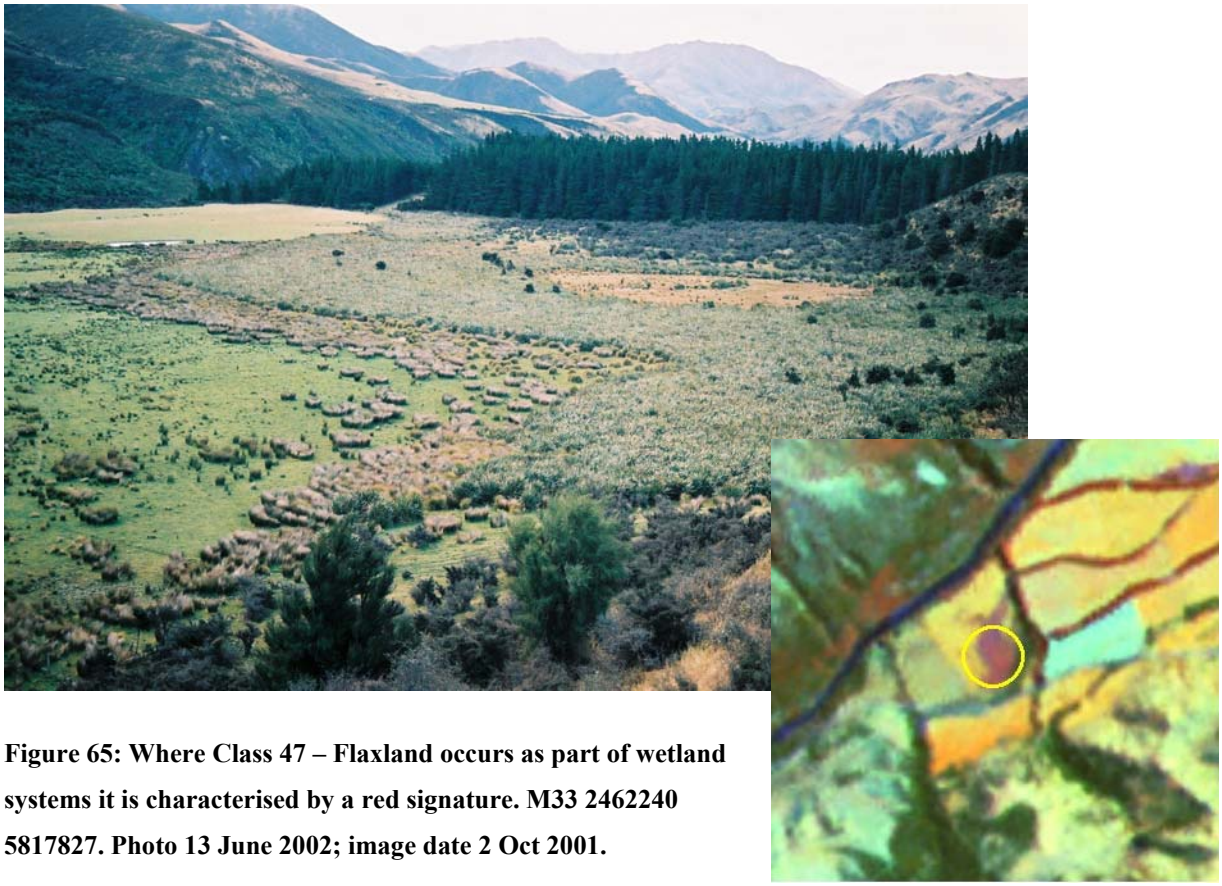


**Figure 65: Where Class 47 – Flaxland occurs as part of wetland systems it is characterised by a red signature. M33 2462240 5817827. Photo 13 June 2002; image date 2 Oct 2001.**

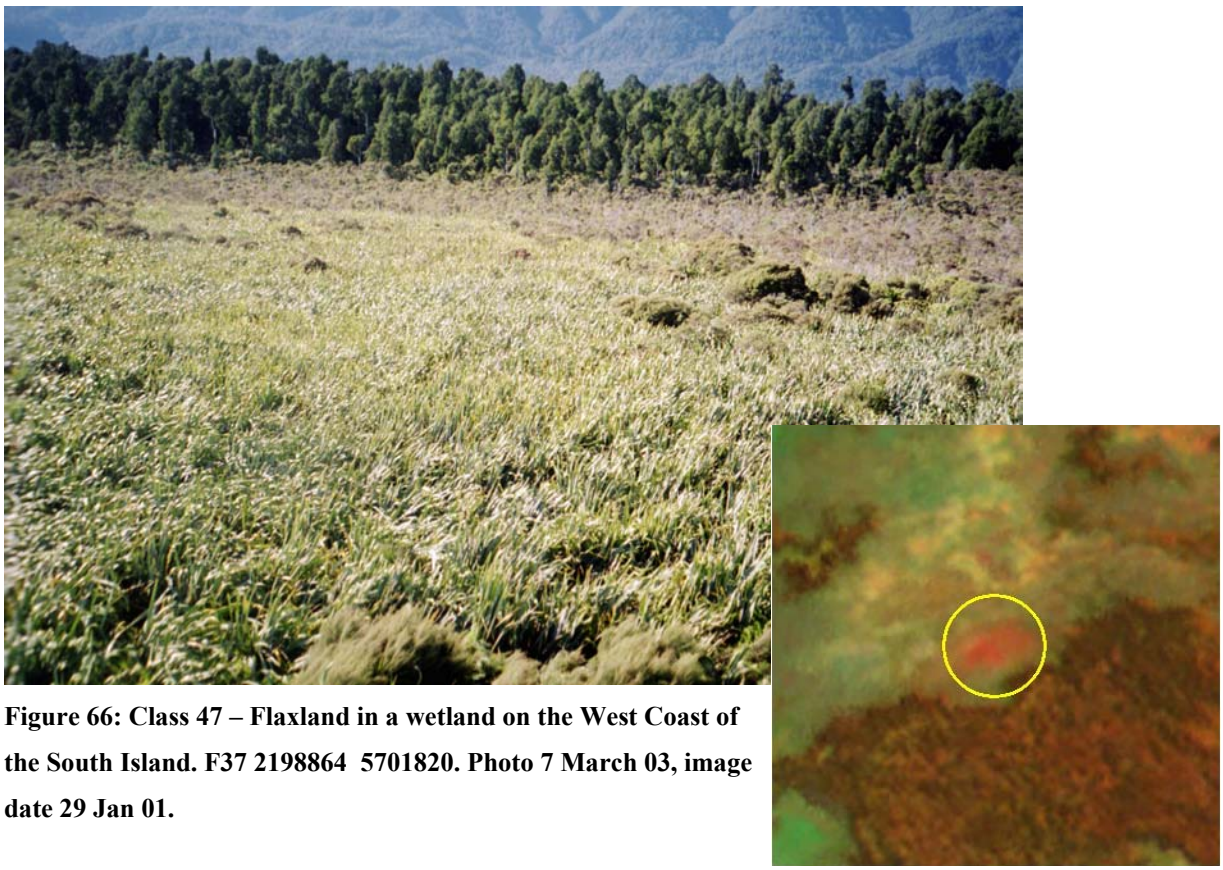


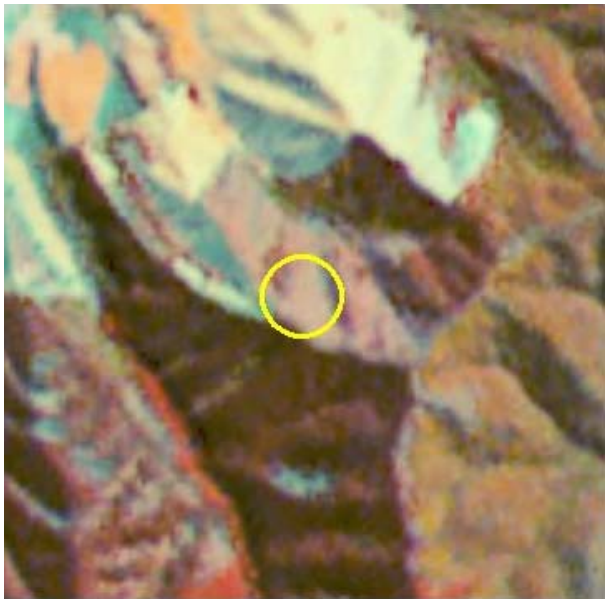
**Figure 66: Class 47 – Flaxland in a wetland on the West Coast of the South Island. F37 2198864  5701820. Photo 7 March 03, image date 29 Jan 01.**

**Scrub and Shrubland**

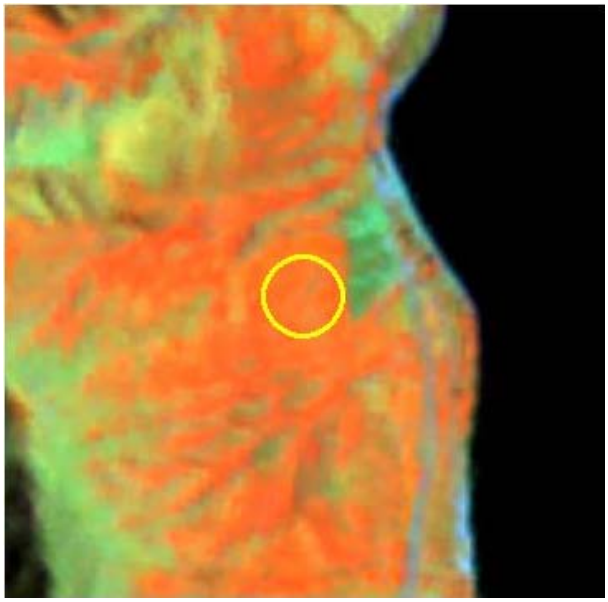
## 50 Fernland:

This class includes areas of dominant bracken fern (*Pteridium esculentum*), umbrella fern (*Gleichenia* species), and ring fern (*Paesia scaberula*). The ferns are often associated with shrubs, such as manuka or kanuka, as the community represents a successional vegetation type on previously forested land. Sites have low fertility and often a history of recent burning. The ferns reach heights of 0.5 - 3m.

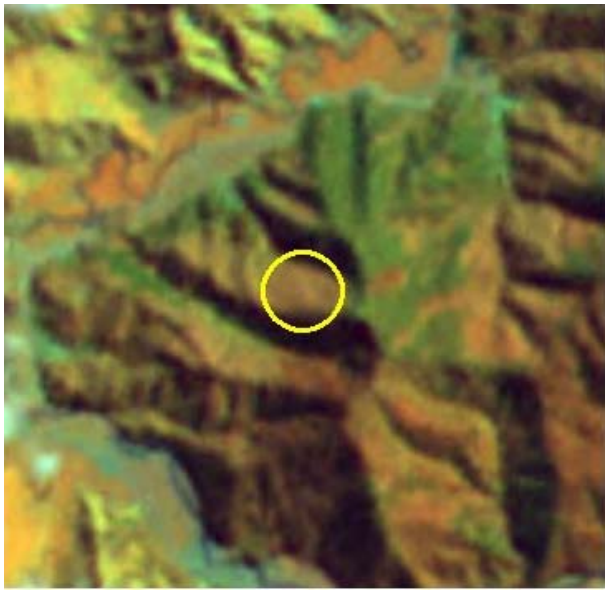
**Figure 70: Class 50 – Fernland. G39 2216493 5625350. Photo 2 Feb 2003, image date 29 Jan 2002.**



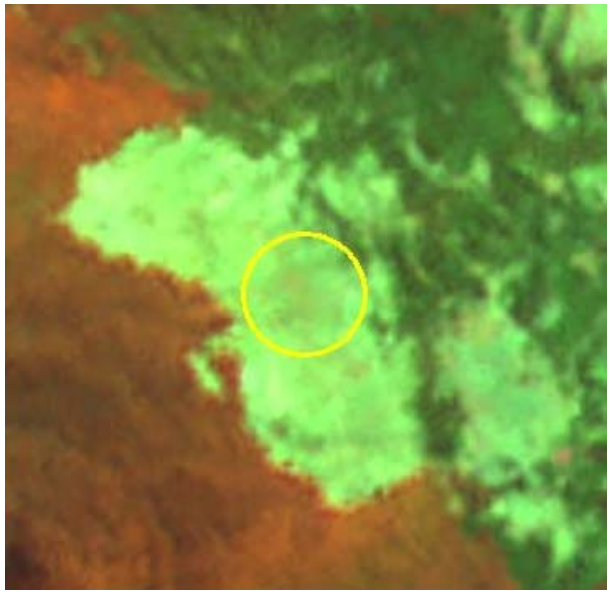
M28 248925 596190. Image 2 Oct 2001.



G39 2211296 5627641. Image 29 Jan 2002.



R16 2661438 6314485. Image 25 Sept 2001.



M32 2457164 5846258. Image 2 Oct 2001.

**Figure 1: Class 50 – Fernland. The signature varies considerably for different areas and seasons.**

**Figure 2: Class 50 – Fernland. Areas of umbrella fern (*Gleichenia* species) are common on formerly forested sites along the West Coast of the South Island. The ferns are associated with manuka (*Leptospermum scoparium*), flax (*Phormium tenax*), gorse (*Ulex europaeus*), broom (*Cytisus scoparius*), and toitoi (*Chionochloa rigida*). L28 2417231 5951635. Photo 5 Aug 03, image date 14 Feb 2002.**

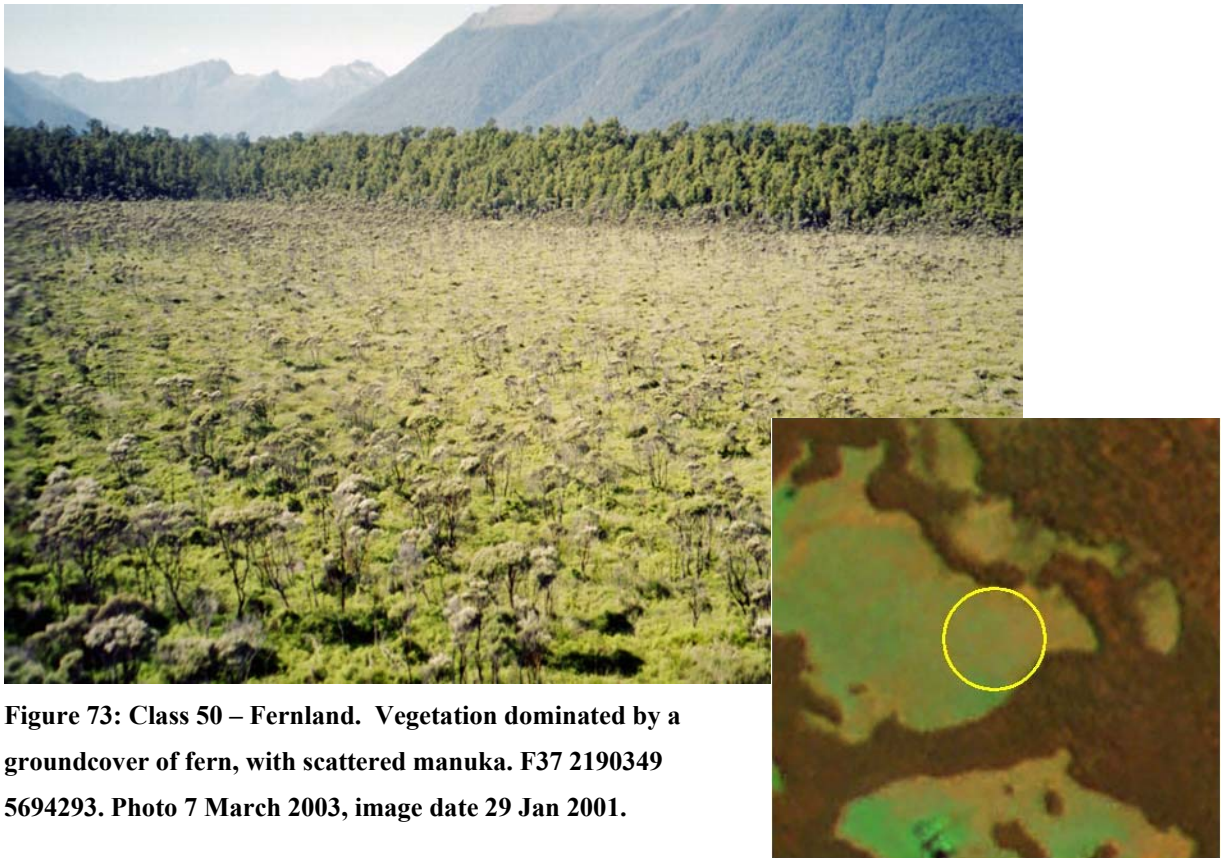


**Figure 73: Class 50 – Fernland. Vegetation dominated by a groundcover of fern, with scattered manuka. F37 2190349 5694293. Photo 7 March 2003, image date 29 Jan 2001.**

## 51 Gorse and/or Broom:

Commonly associated with Low Producing Exotic Grassland on hill country throughout New Zealand, where low site fertility, extensive grazing and fire facilitate the plants' spread and establishment. Gorse and/or broom will reach heights of 1 - 2m, and are typical of land subject to frequent physical disturbance such as aggrading river beds, road cuttings, and firebreaks. Either of these species can be dominant, but they also occur in mixtures. Left undisturbed, the class is transitional towards indigenous broadleaved shrubland and eventually tall forest. The period this occurs over is strongly related to rainfall. Gorse and broom scrub have been grouped together in one land cover class.

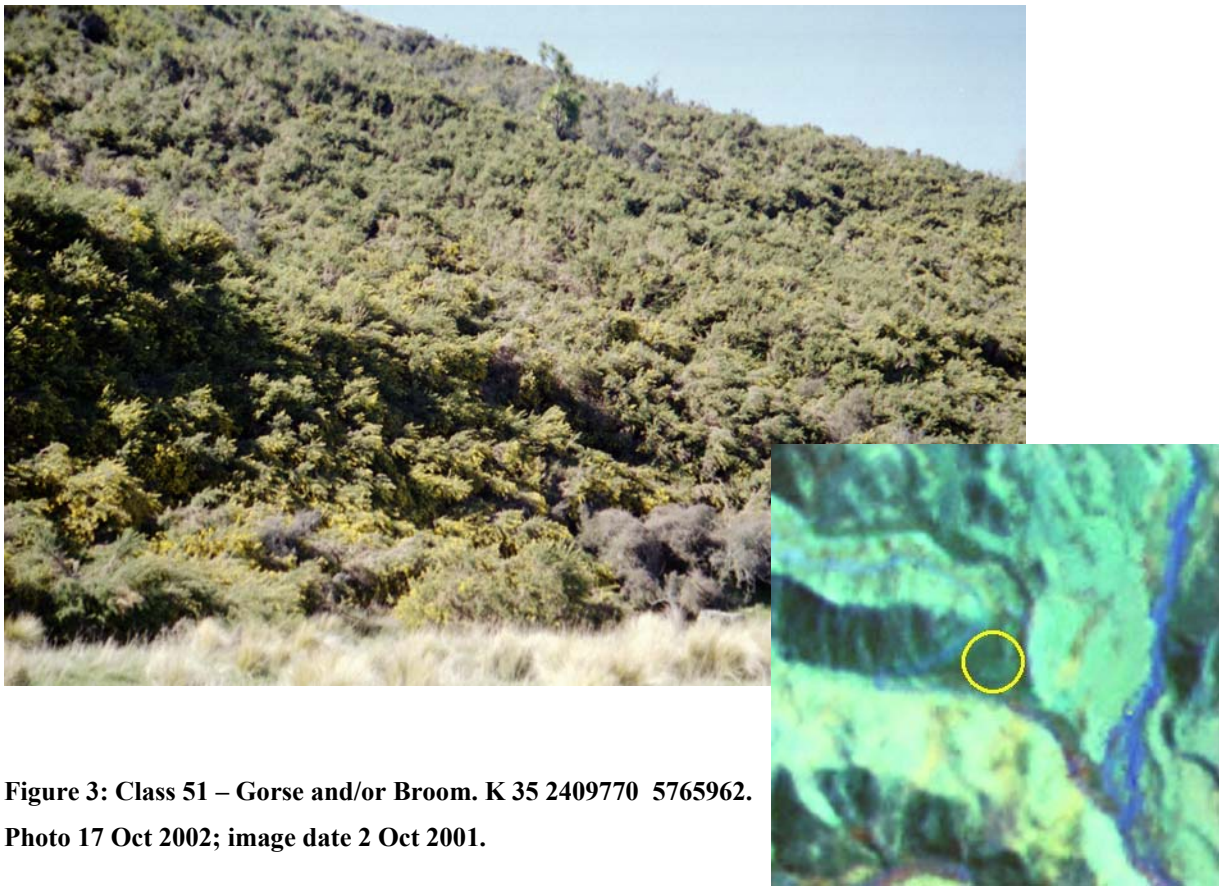


**Figure 3: Class 51 – Gorse and/or Broom. K 35 2409770 5765962. Photo 17 Oct 2002; image date 2 Oct 2001.**

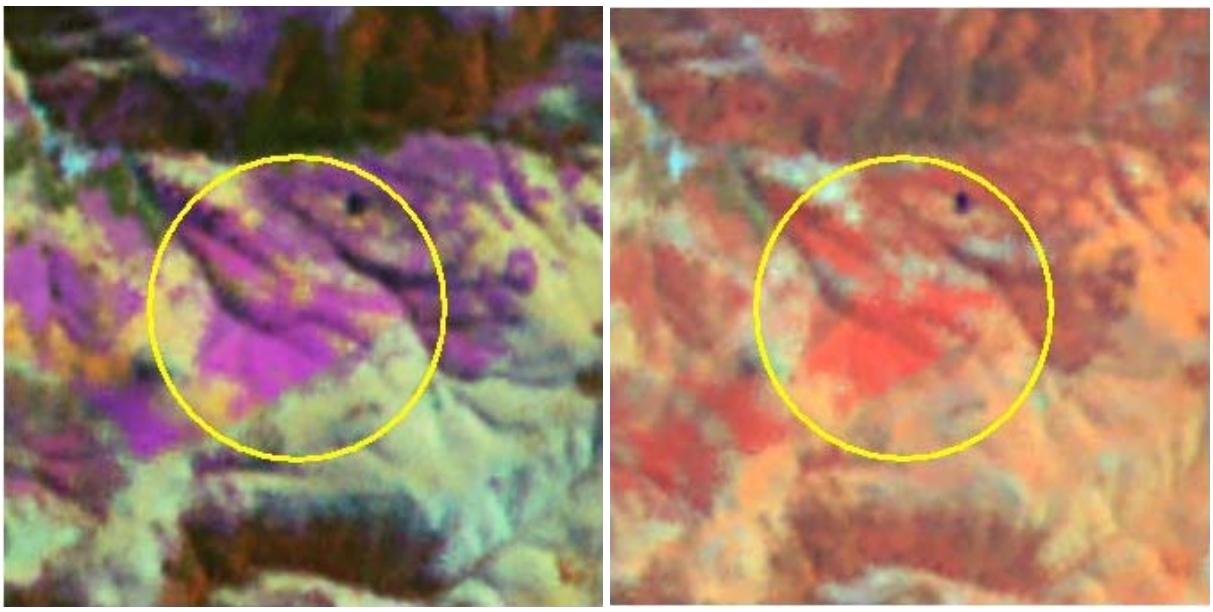
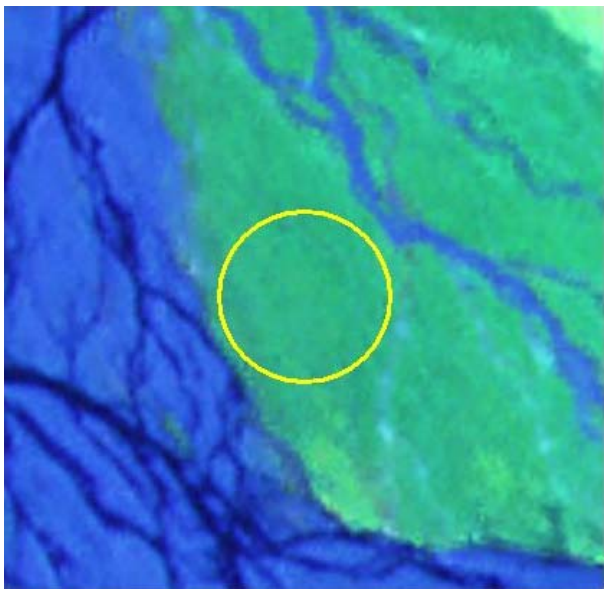
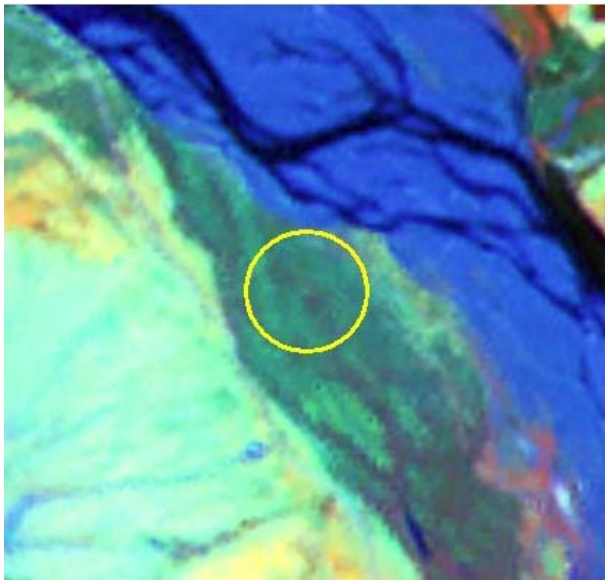


**Figure 4: The signature of Class 51 - Gorse and/or Broom shows strong seasonal variation. The images show the same area in the Port Hills, Christchurch (M 36 2478232  5726053). In spring (left, image date 2 Oct 2001) the signature shows a strong purple, while it is bright red in summer (right, image date 30 Dec 2001).**



K35 2383643 5763055, on riverbed island.



K35 2393567 5754911, on riverbank.

K35 2404397 5715587, in hillcountry.

**Figure 5: The signature of Class 51 – Gorse and/or Broom varies considerably between different sites. All images 2 Oct 2001.**

## 52 Manuka and/or Kanuka:

Indigenous shrubland found throughout New Zealand often associated with lightly grazed hill country. Typically found as early successional scrub type on previously forested land with a history of burning to control scrub reversion. Presence of mature stands signifies an advanced stage of reversion, also indicated by the presence of broadleaved forest species. Manuka (*Leptospermum scoparium*) or kanuka (*Kunzea ericoides*) can be dominant, but they also occur in mixtures. Both species have been grouped together in one land cover class. Kanuka is more common in the North Island with a maximum height of 8-10m on moist sites. Manuka dominates South Island communities with a maximum height of 2-6m.

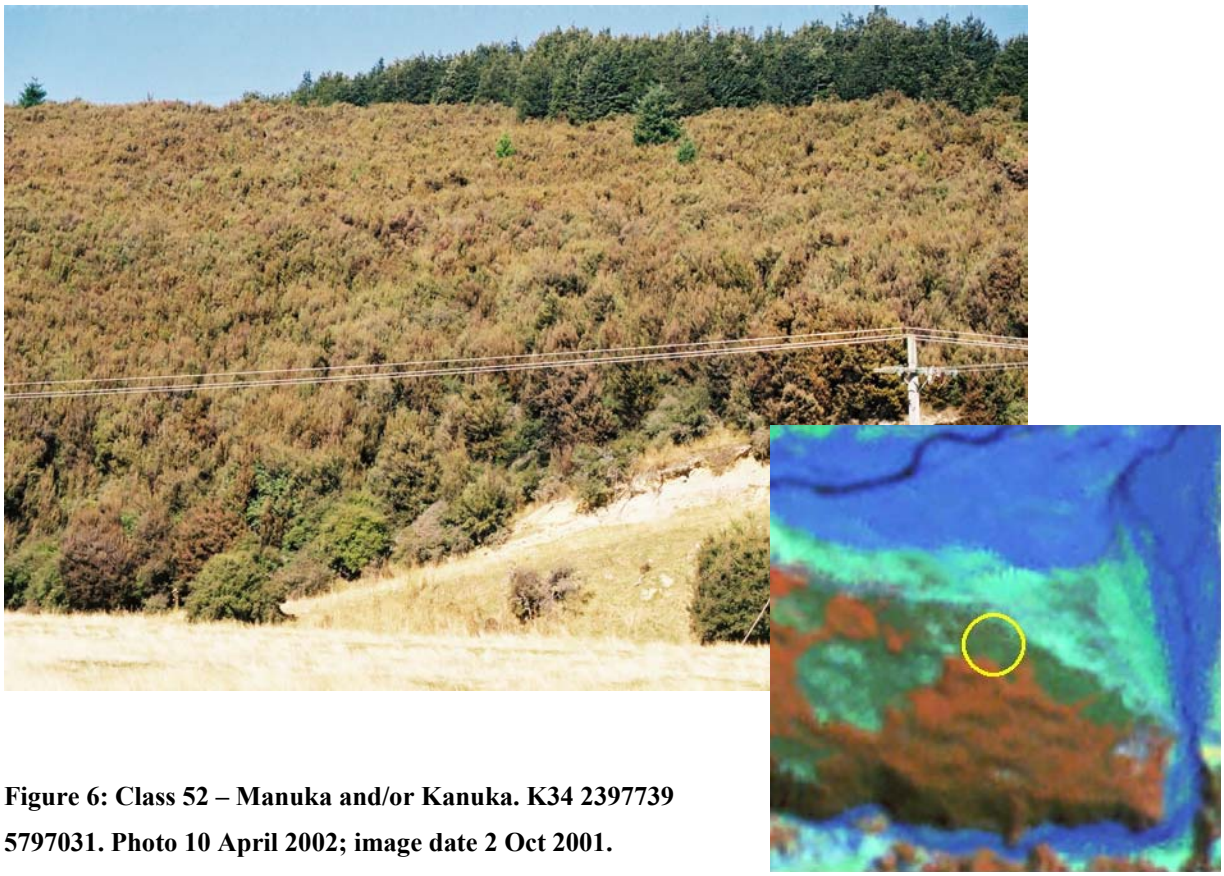


**Figure 6: Class 52 – Manuka and/or Kanuka. K34 2397739 5797031. Photo 10 April 2002; image date 2 Oct 2001.**

**Figure 7: Class 52 – Manuka and/or Kanuka. P31 735 899. Photo 24 June 2002; image date 30 Dec 2001.**

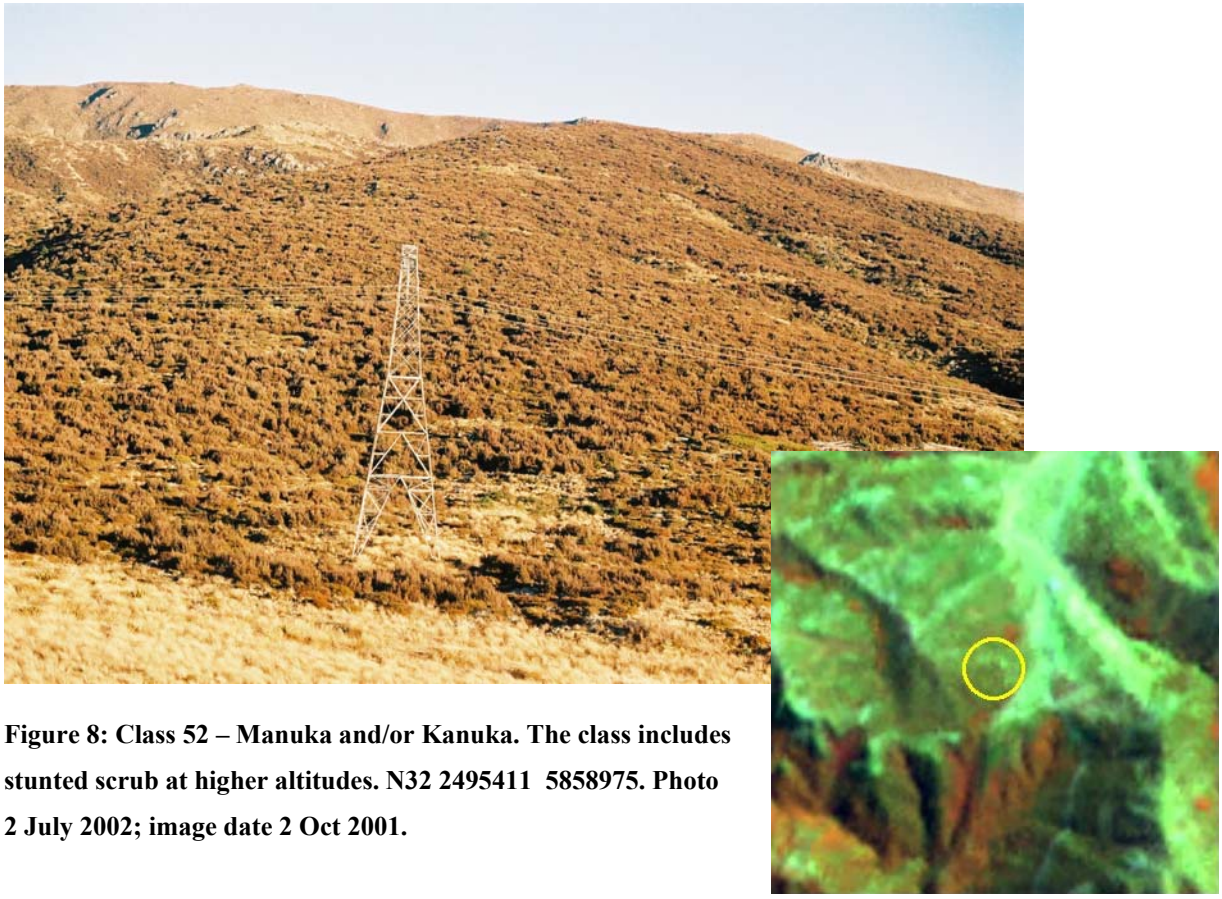


**Figure 8: Class 52 – Manuka and/or Kanuka. The class includes stunted scrub at higher altitudes. N32 2495411 5858975. Photo 2 July 2002; image date 2 Oct 2001.**

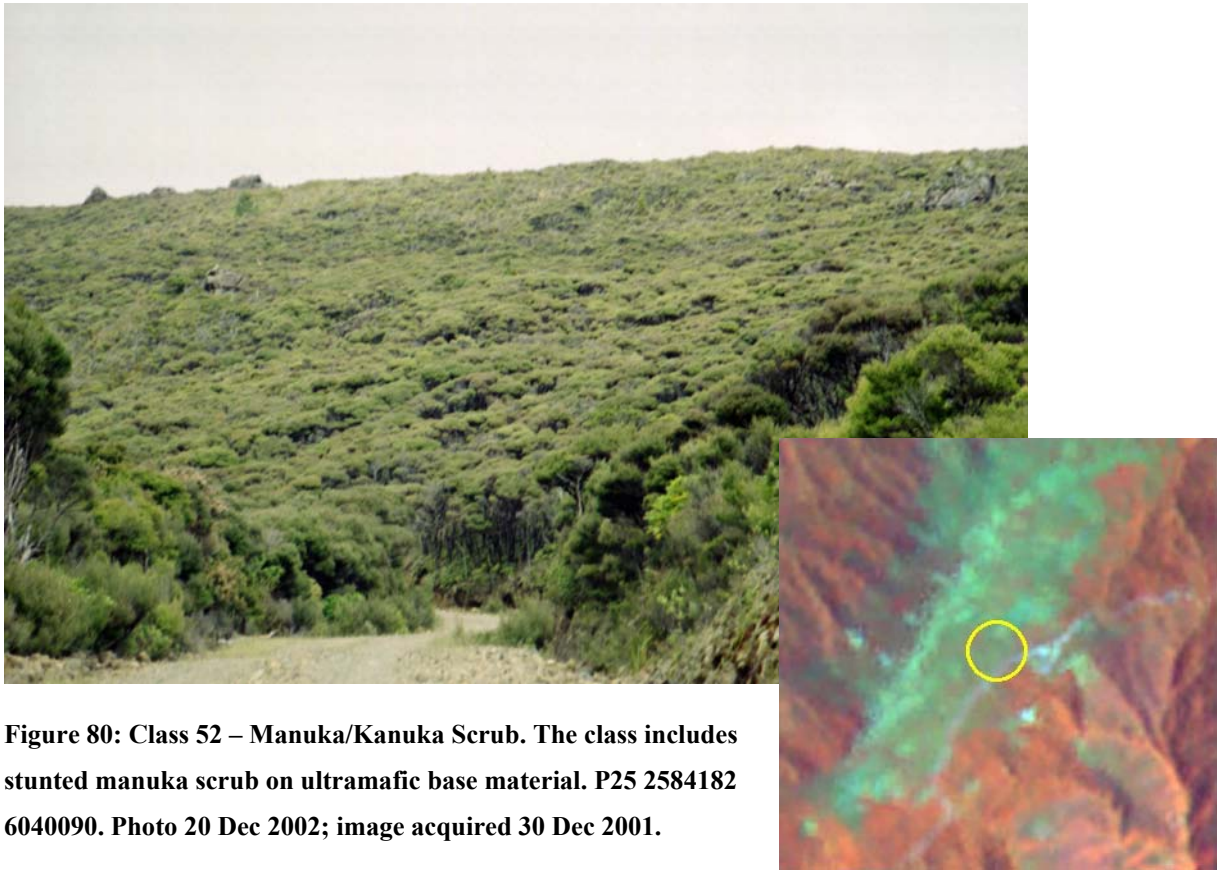
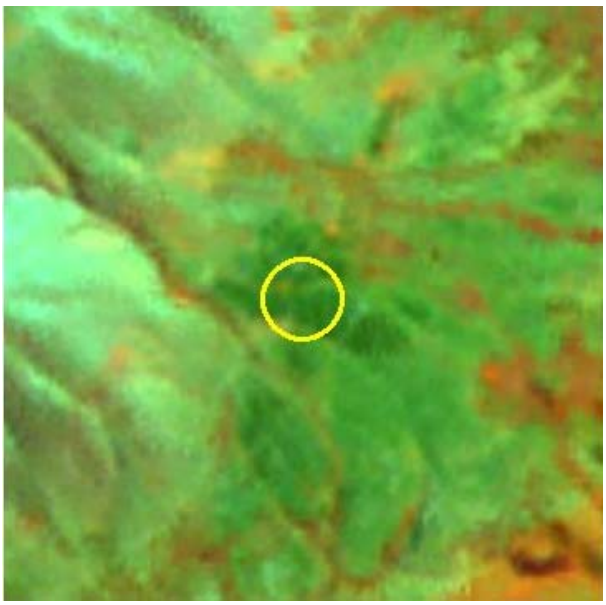
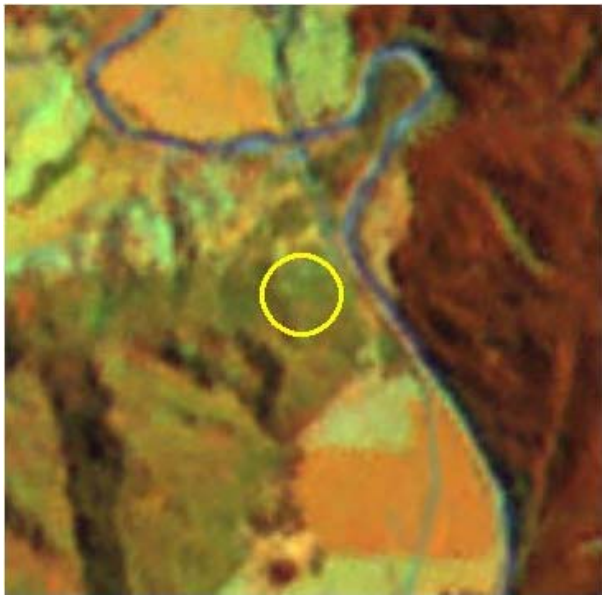


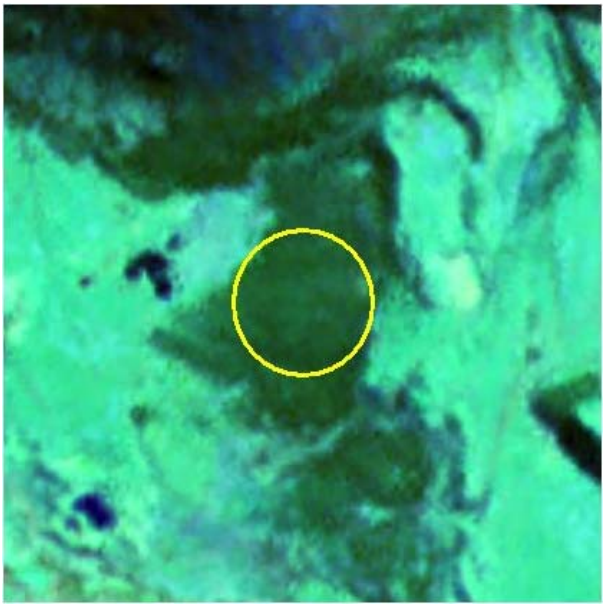
**Figure 80: Class 52 – Manuka/Kanuka Scrub. The class includes stunted manuka scrub on ultramafic base material. P25 2584182 6040090. Photo 20 Dec 2002; image acquired 30 Dec 2001.**



H38 2269955 5659726. Image date 29 Jan 2002.



Z16 2970187 6319284. Image date 18 Feb 2002.



K35 2395427 5766751 Image date 2 Oct 2001.

**Figure 9: The signature of Class 52 – Manuka and / or Kanuka shows a characteristic green, although the depth and hue vary between regions.**

## 53 Matagouri:

A divaricating, thorny shrub reaching a height of 1 - 2m found in open shrubland or thickets. Matagouri (*Discaria toumatou*) is restricted to montane areas of the South Island and is often associated with Low Producing Grassland. Matagouri is commonly found on freely drained recent soils, especially on river terraces and outwash fans. Matagouri benefits from certain farm management practices, in particular phosphate fertiliser application, and therefore, occurs often in extensively managed grazing country. Its open growth habit and low plant biomass relative to height mean that areas are difficult to reliably detect in the satellite imagery. Therefore, areas mapped are generally thickets or older stands where the canopy is dense, while more open or young stands can often not be separated from the surrounding grassland.

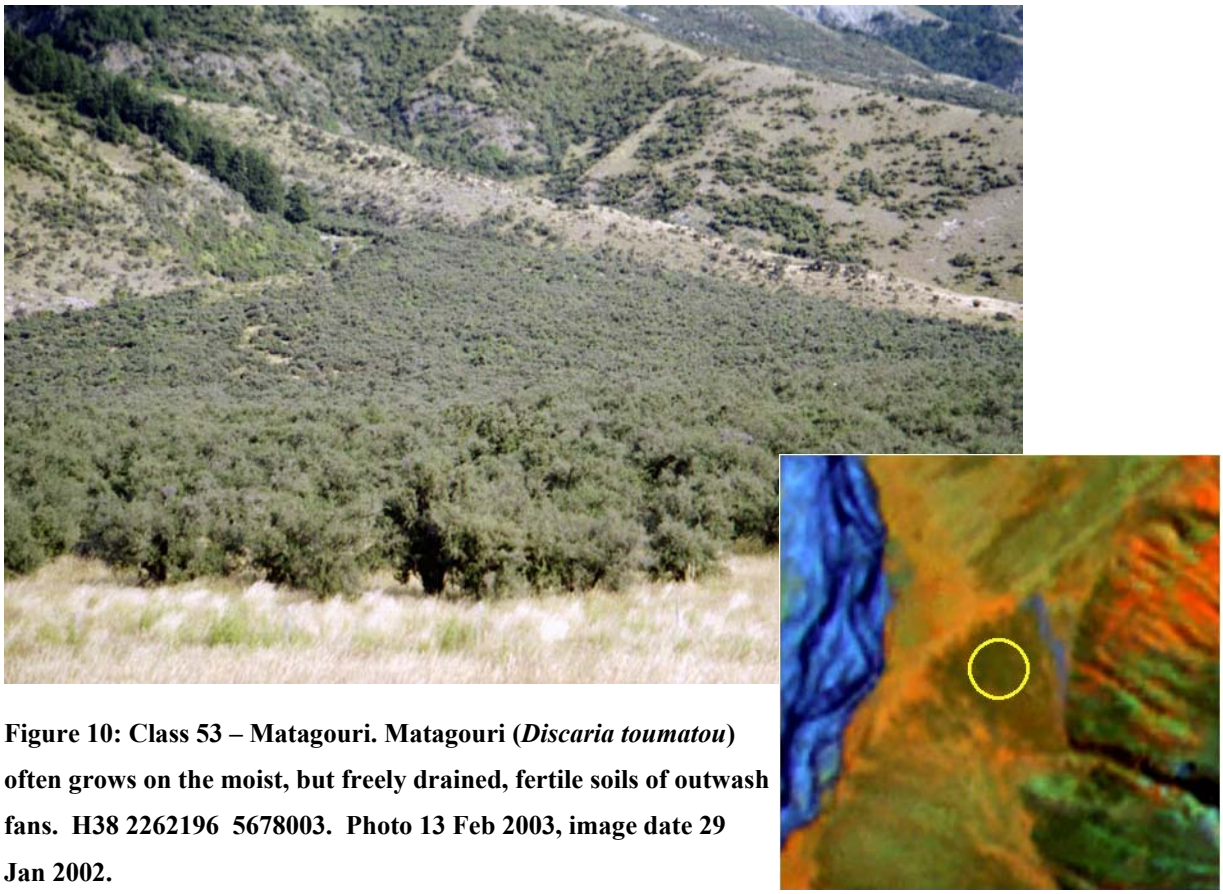
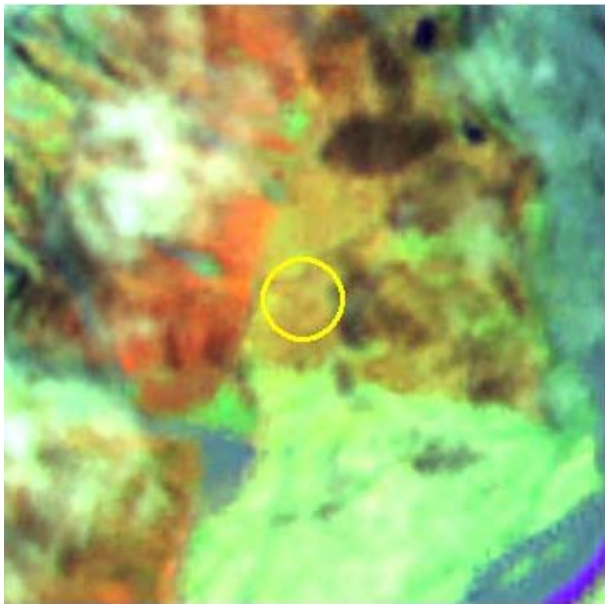
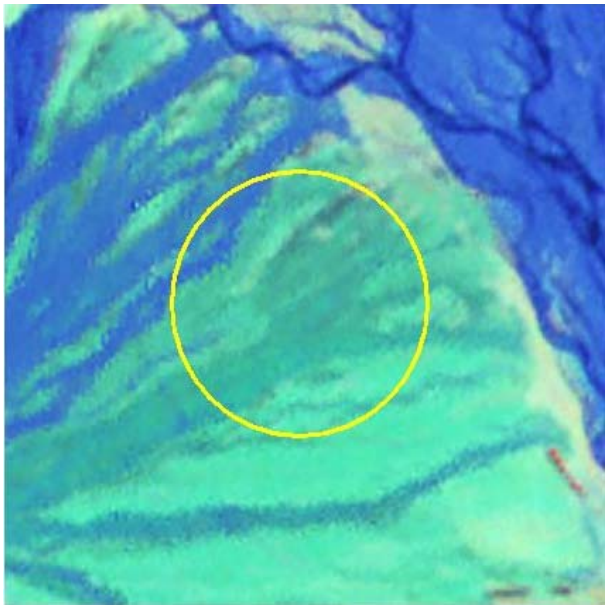


**Figure 10: Class 53 – Matagouri. Matagouri (*Discaria toumatou*) often grows on the moist, but freely drained, fertile soils of outwash fans. H38 2262196 5678003. Photo 13 Feb 2003, image date 29 Jan 2002.**



H36 2281026 5719051. Image date 13 Feb 2002.



J36 2340553 5730278. Image date 2 Oct 2001

**Figure 11: The signature of Class 53 – Matagouri is variable depending on the density of the scrub cover and local site conditions.**

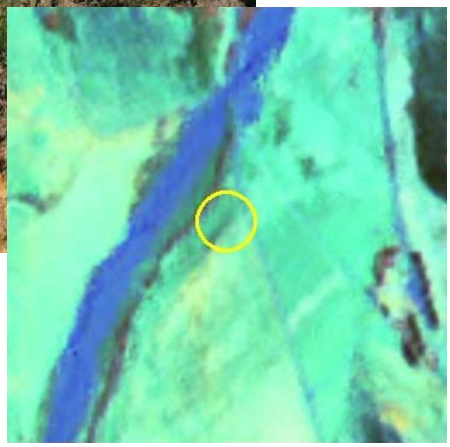


**Figure 12: Some stands of seemingly dense matagouri only show an indistinct grey signature in the imagery. K34 2407938 5796516. Photo 10 April 2002; image date 2 Oct 2001.**

## 54 Broadleaved Indigenous Hardwoods:

Typically found in high rainfall areas associated with Low Producing Exotic Grassland in hill country throughout New Zealand. However. the class also includes low-growing, coastal broadleaved forest. Characteristic is the presence of a mix of broad-leaved, generally seral hardwood species, such as wineberry (*Aristotelia serrata*), mahoe (*Melicytus ramiflorus*), *Pseudopanax* spp., *Pittosporum* spp., *Fuchsia* spp., ngaio (*Myoporum laetum*), and titoki (*Alectryon excelsus*), together with tutu (*Coriaria* spp.) and tree ferns. The presence of this class usually indicates an advanced successional stage back to indigenous forest. Canopy height ranges from 3 - 10m.

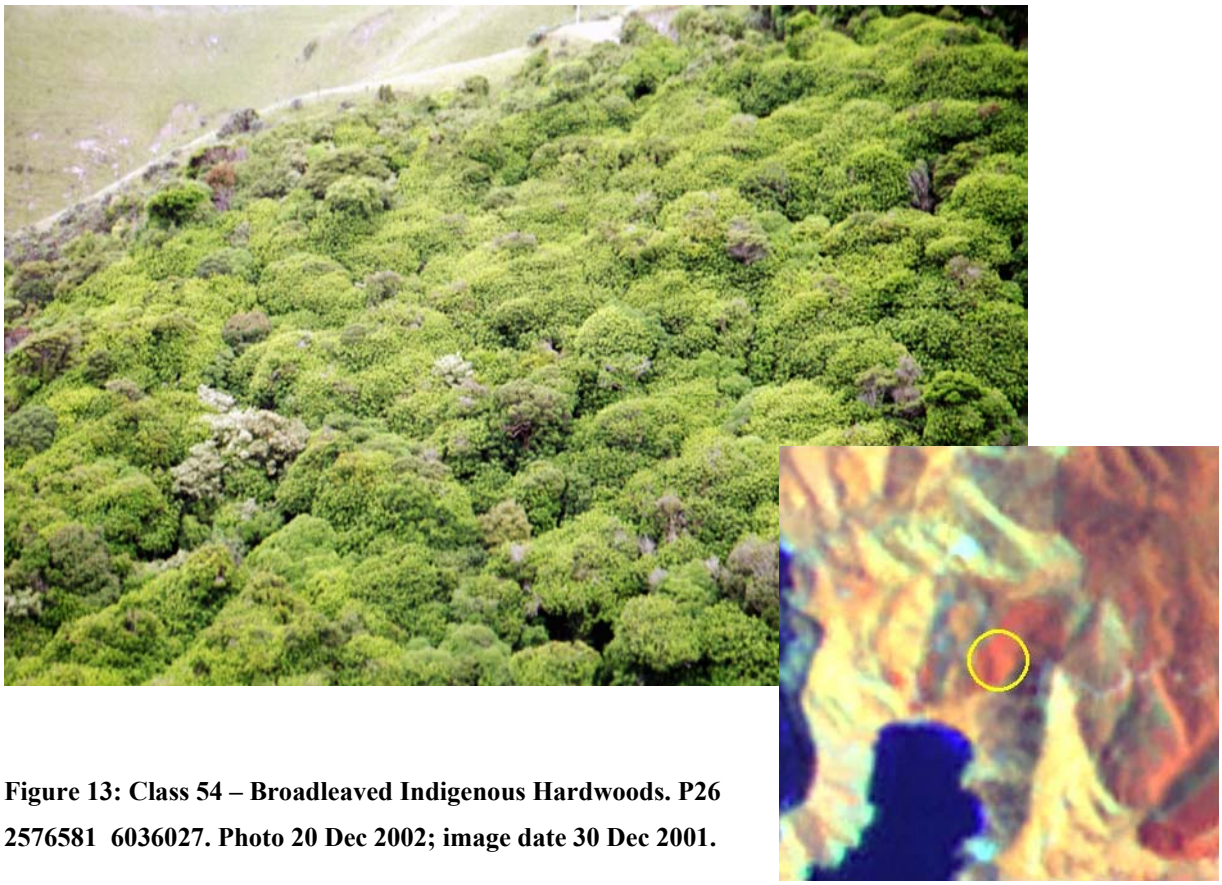


**Figure 13: Class 54 – Broadleaved Indigenous Hardwoods. P26 2576581 6036027. Photo 20 Dec 2002; image date 30 Dec 2001.**

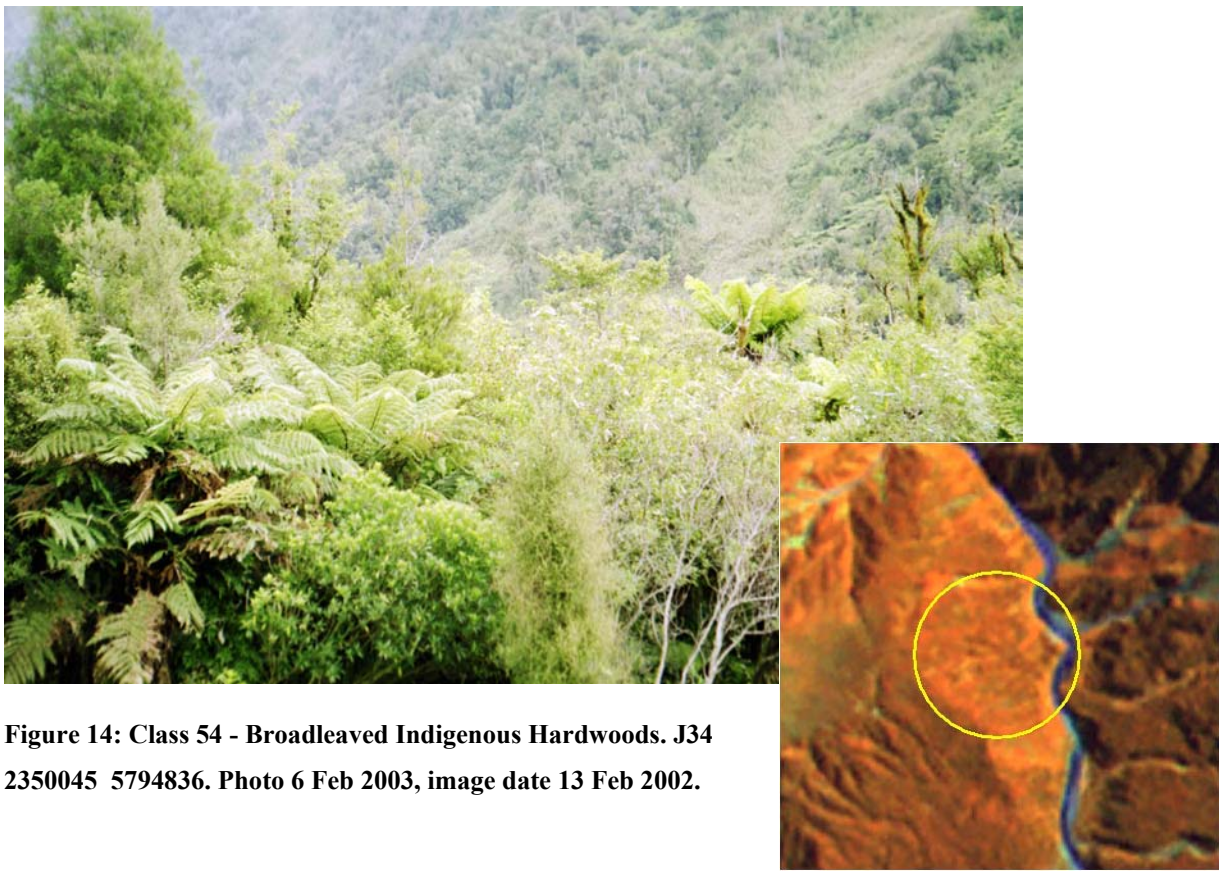


**Figure 14: Class 54 - Broadleaved Indigenous Hardwoods. J34 2350045 5794836. Photo 6 Feb 2003, image date 13 Feb 2002.**

## 55 Sub-alpine Shrubland:

This class includes a diverse range of shrubland communities usually occurring within an altitudinal range of 900 - 1200m, but also at lower altitudes where they represent secondary vegetation after forest clearance. The class is transitional between Indigenous Forest at lower altitudes and Tall Tussock Grassland, Alpine Grass-/Herbfieds, and Alpine Gravel and Rock above 1200 - 1300m. Communities are more stable than lowland scrub types with composition and height strongly influenced by rainfall and exposure. Typical species present include *Hebe, Olearia, Dracophyllum* and *Cassinia* with canopy height ranging from 0.3 - 4m.

The class also includes frostflat areas at lower altitudes, where comparable scrub types have established due to microclimatic conditions. Such areas are widespread in the central North Island.

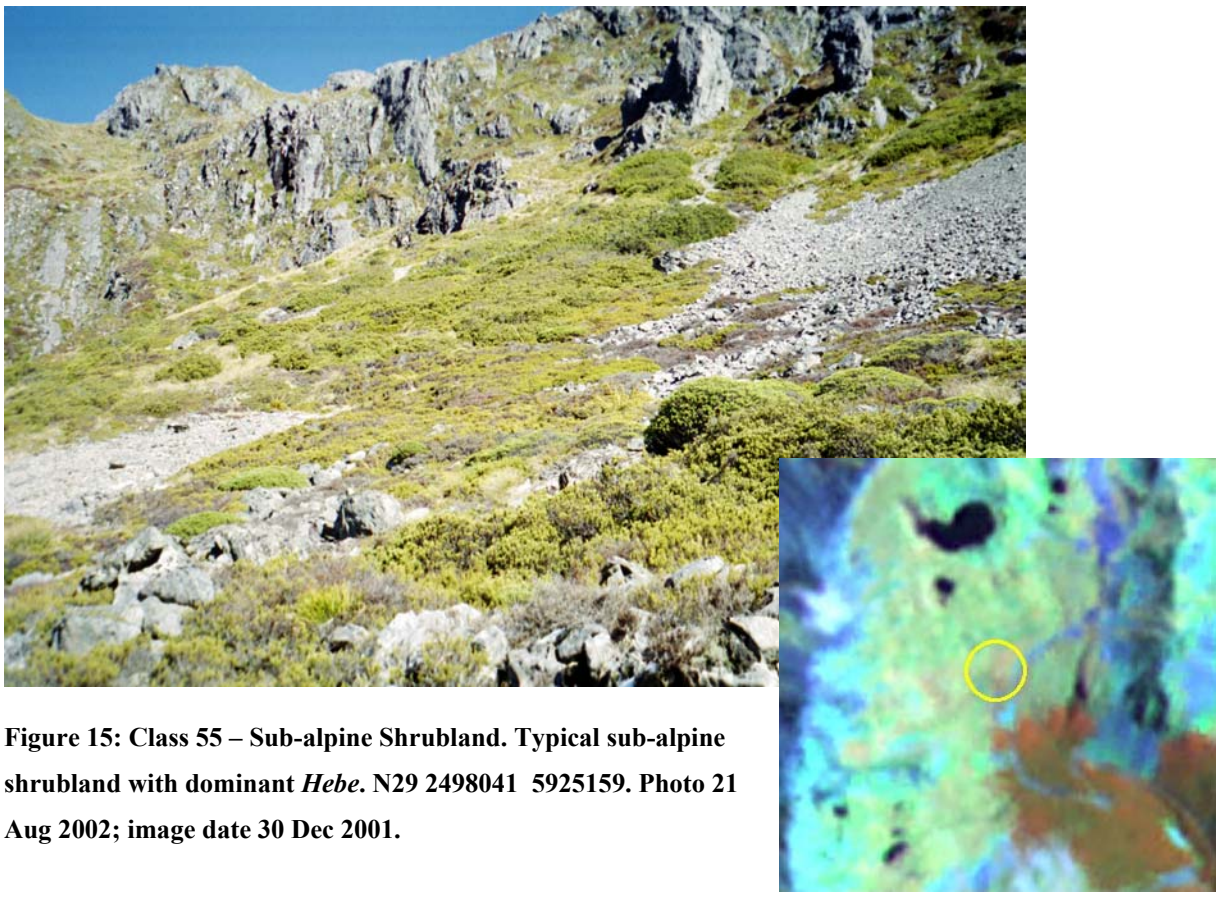


**Figure 15: Class 55 – Sub-alpine Shrubland. Typical sub-alpine shrubland with dominant *Hebe*. N29 2498041 5925159. Photo 21 Aug 2002; image date 30 Dec 2001.**

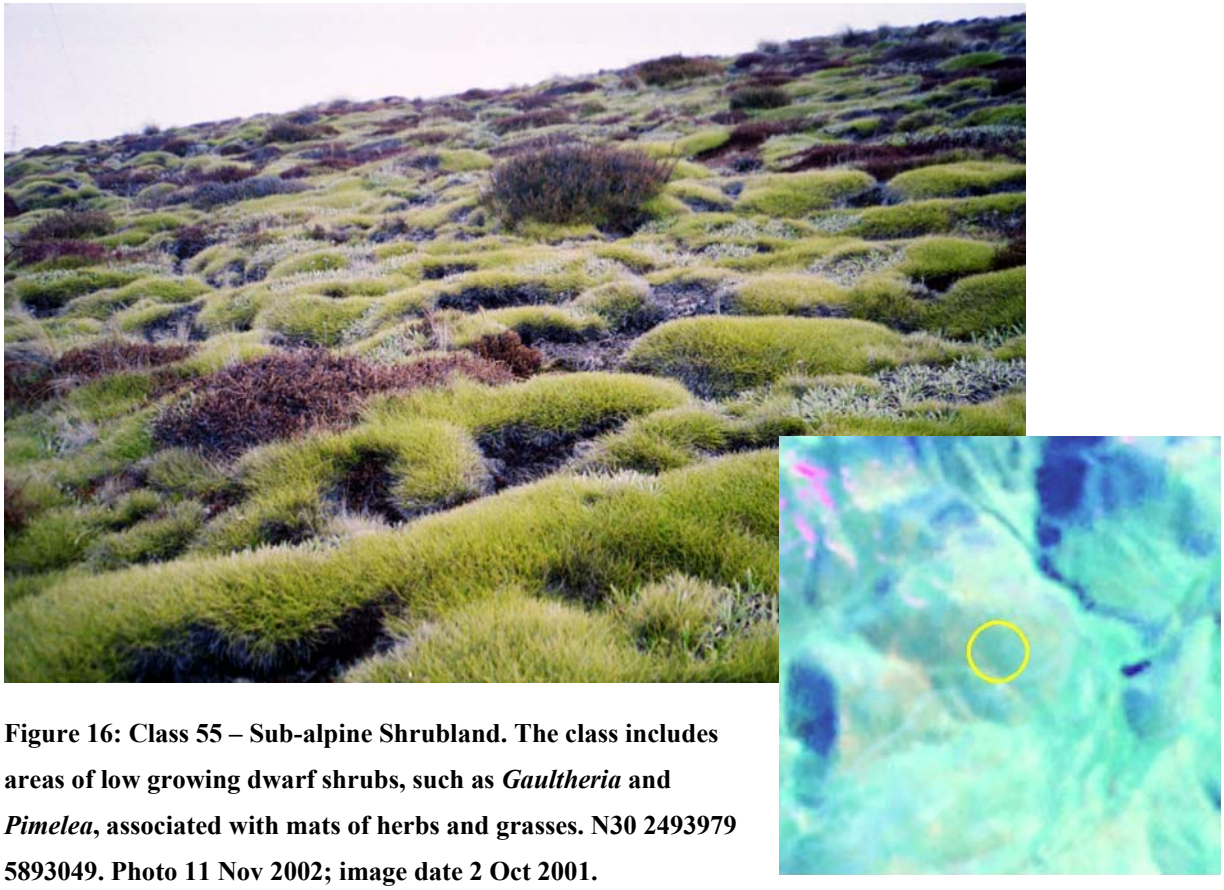


**Figure 16: Class 55 – Sub-alpine Shrubland. The class includes areas of low growing dwarf shrubs, such as *Gaultheria* and *Pimelea*, associated with mats of herbs and grasses. N30 2493979 5893049. Photo 11 Nov 2002; image date 2 Oct 2001.**

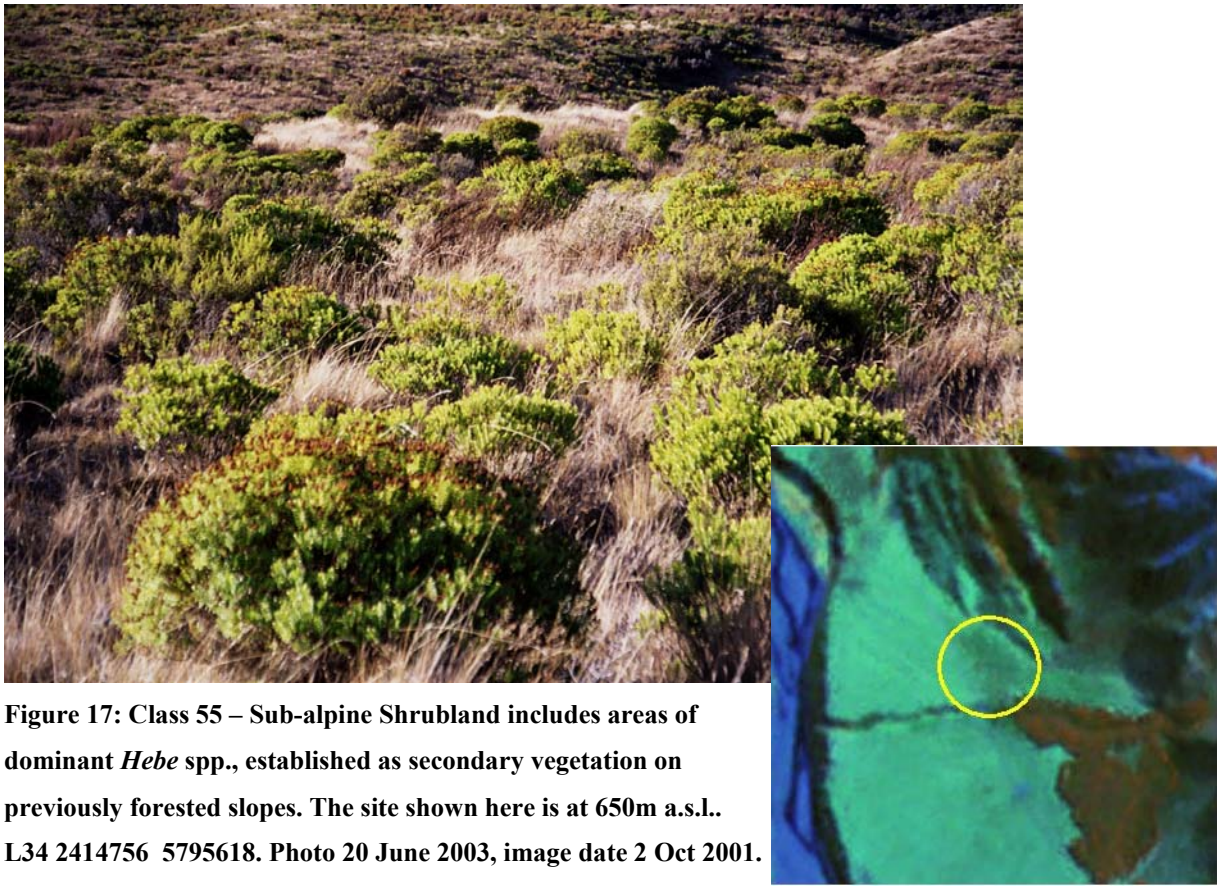


**Figure 17: Class 55 – Sub-alpine Shrubland includes areas of dominant *Hebe* spp., established as secondary vegetation on previously forested slopes. The site shown here is at 650m a.s.l.. L34 2414756 5795618. Photo 20 June 2003, image date 2 Oct 2001.**

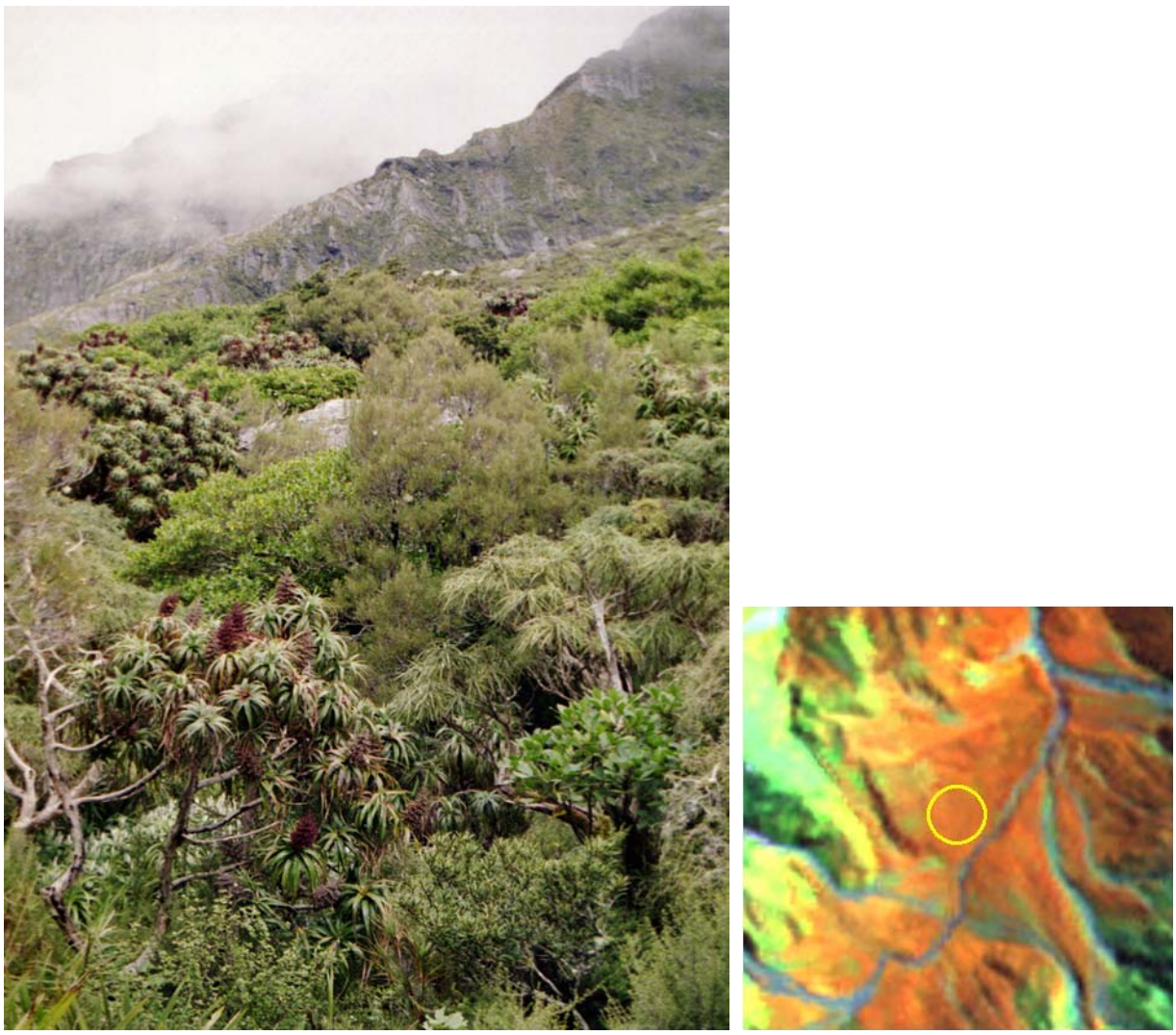
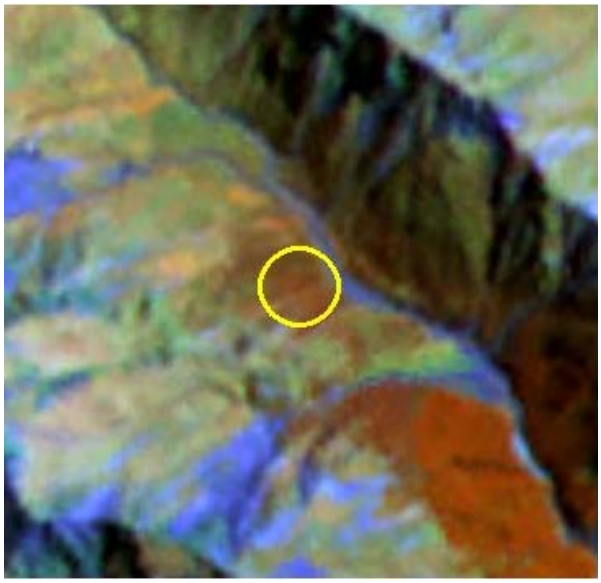


**Figure 90: Class 55 – Sub-alpine Shrubland. The class includes tall growing scrub up to 3m with *Dracophyllum* and *Olearia* spp.. I 35 2302546  5749633. Photo 28 Dec 2002; image date 14 Feb 2002.**

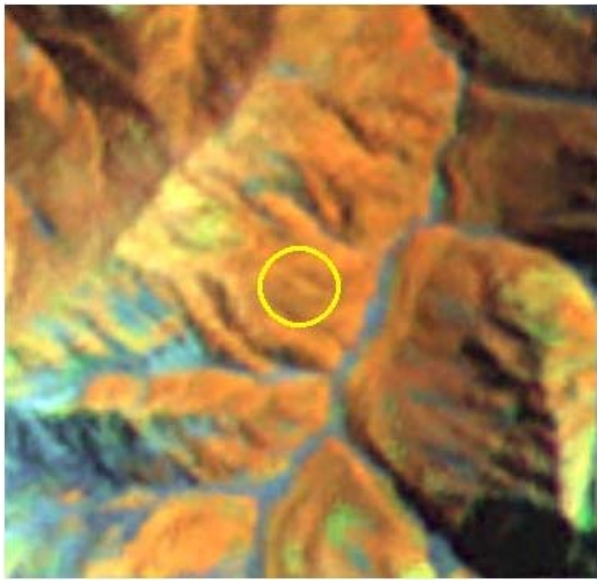
**Figure 18: Class 55 – Sub-alpine Shrubland. The class includes areas dominated by mountain flax (*Phormium hookeri*). O31 2545185 5874201. Photo 31 Jan 2003, image 30 Dec 2001.**

**Figure 19: Class 55 – Subalpine Shrubland. The class includes scrub dominated by *Dracophyllum* and *Olearia* species. F37 2207509 5691195. Photo 7 March 2003, image date 209 Jan 2001.**

**Figure 20: Class 55 – Subalpine Shrubland. The class includes areas of *Hebe* spp., here in a forest clearing at 900m a.s.l.. D40 2128050 5593097. Photo 16 May 2003, image date 20 Jan 2002.**

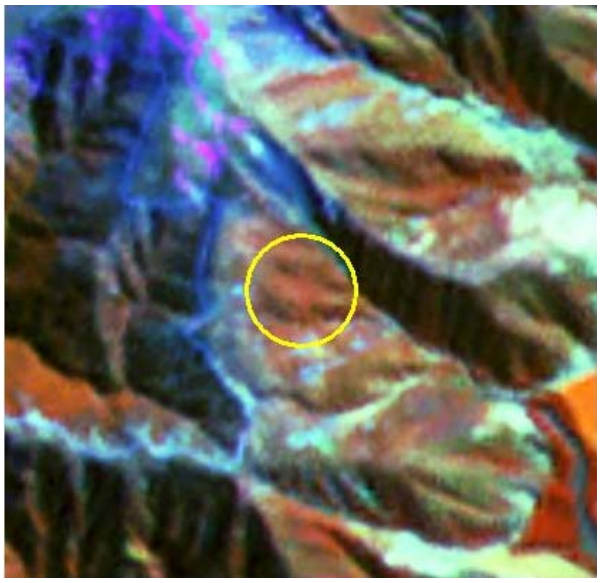


G39 2213122 5640870. Image 29 Jan 2002.



J34 2359729 5793108. Image 14 Feb 2002.

J35 2330441 5769058. Image 2 Oct 2001.



K35 2393306 5741127. Image 2 Oct 2001.

**Figure 21: The signature of Sub-alpine Shrubland varies considerably between different areas, mainly depending on the structure and composition of the vegetation.**

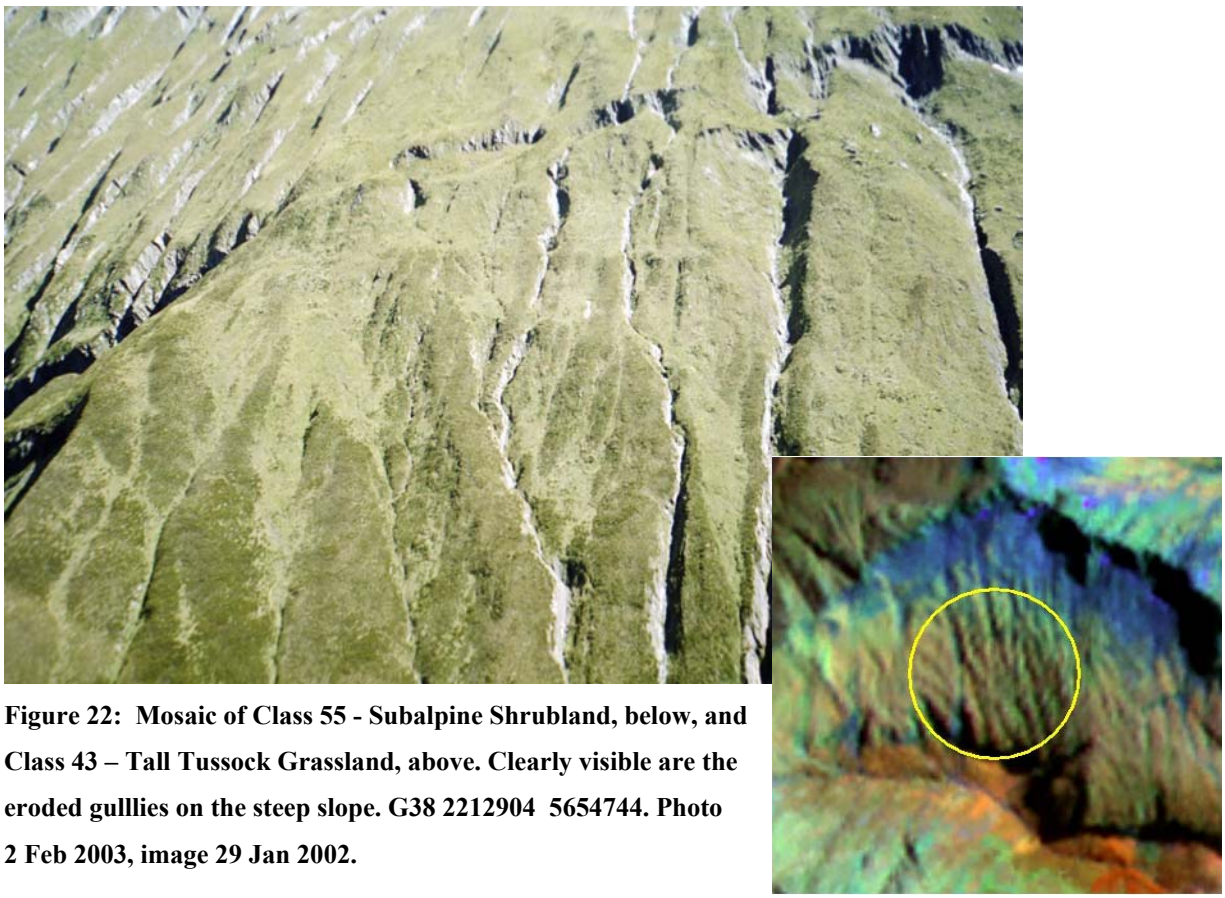


**Figure 22: Mosaic of Class 55 - Subalpine Shrubland, below, and Class 43 – Tall Tussock Grassland, above. Clearly visible are the eroded gulllies on the steep slope. G38 2212904 5654744. Photo 2 Feb 2003, image 29 Jan 2002.**

**56 Mixed Exotic Shrubland:**

Single-species or mixed communities of introduced shrubs and climbers, such as boxthorn, hawthorn (*Crataegus* spp.), elderberry (*Sambucus* spp.), brier (*Rosa rubiginosa*), buddleja (*Buddleja davidii*), blackberry (*Rubus* spp.), and old man's beard (*Clematis vitalba*).

The class also includes areas of amenity planting where the shrubland component reaches the 1 ha MMU.

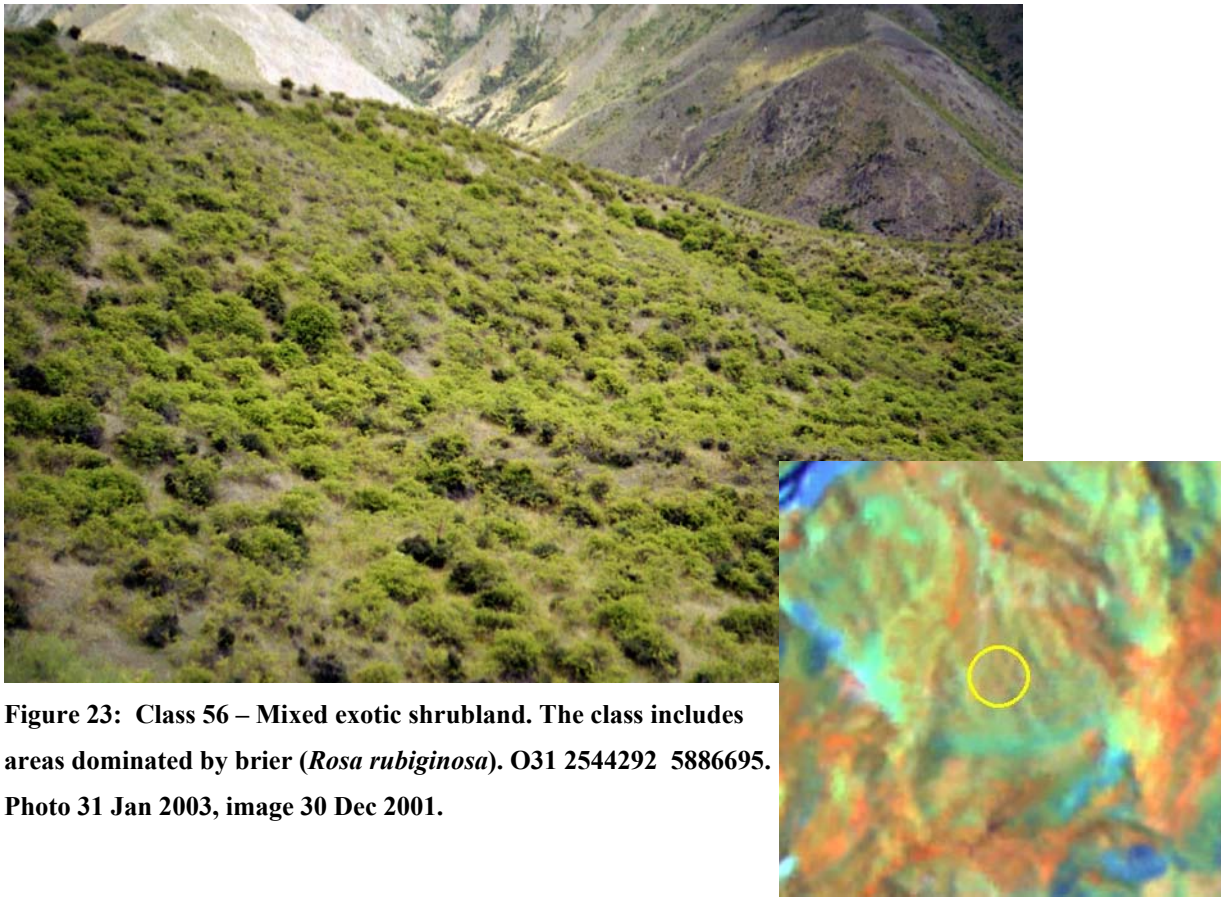


**Figure 23: Class 56 – Mixed exotic shrubland. The class includes areas dominated by brier (*Rosa rubiginosa*). O31 2544292 5886695. Photo 31 Jan 2003, image 30 Dec 2001.**

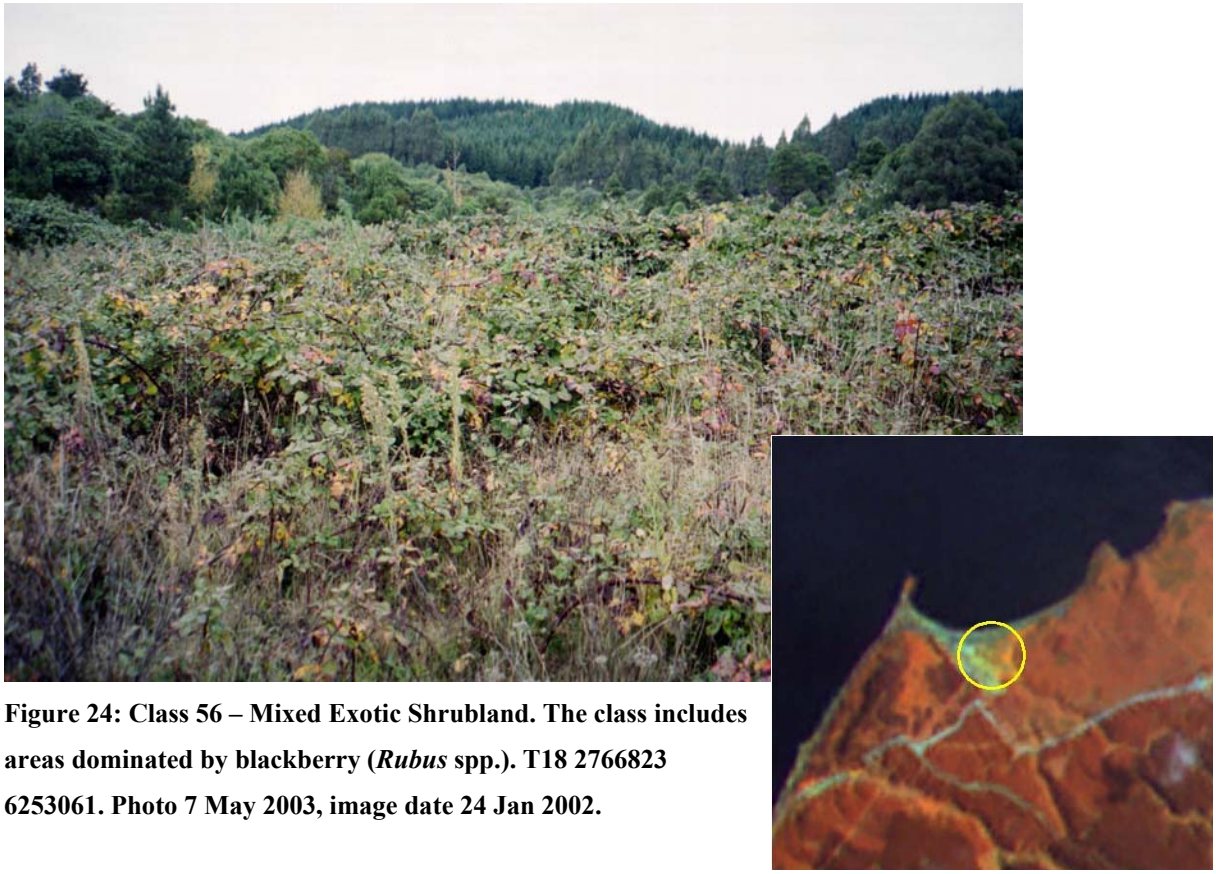


**Figure 24: Class 56 – Mixed Exotic Shrubland. The class includes areas dominated by blackberry (*Rubus* spp.). T18 2766823 6253061. Photo 7 May 2003, image date 24 Jan 2002.**

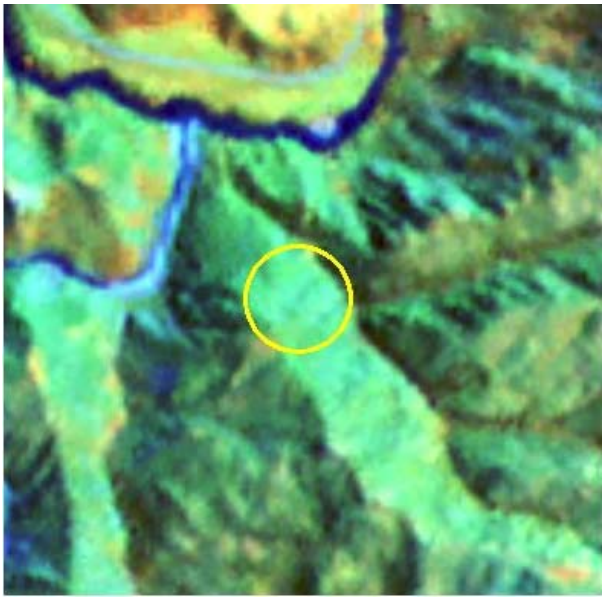


**Figure 25: F41 2198321 5563783. The signature of thyme (*Thymus vulgaris*), an introduced dwarf shrub, covering extensive areas in Central Otago. Image date 29 Jan 2001.**

## 57 Grey Scrub:

Areas of small-leaved indigenous shrubs with mainly divaricate growth form, i.e. the shrubs form dense masses of entangled, fine branches by branching at almost right angles. Small-leaved *Coprosma* are usually dominant. Characteristic is also the presence of native climbers such as *Muehlenbeckia* and *Parsonsia*. From a distance these areas have a grey appearance (hence 'grey scrub'), as the woody component is the dominant feature, while leaves are small and inconspicuous. Areas of dominantly manuka / kanuka and matagouri are mapped separately (see classes 52 and 53).

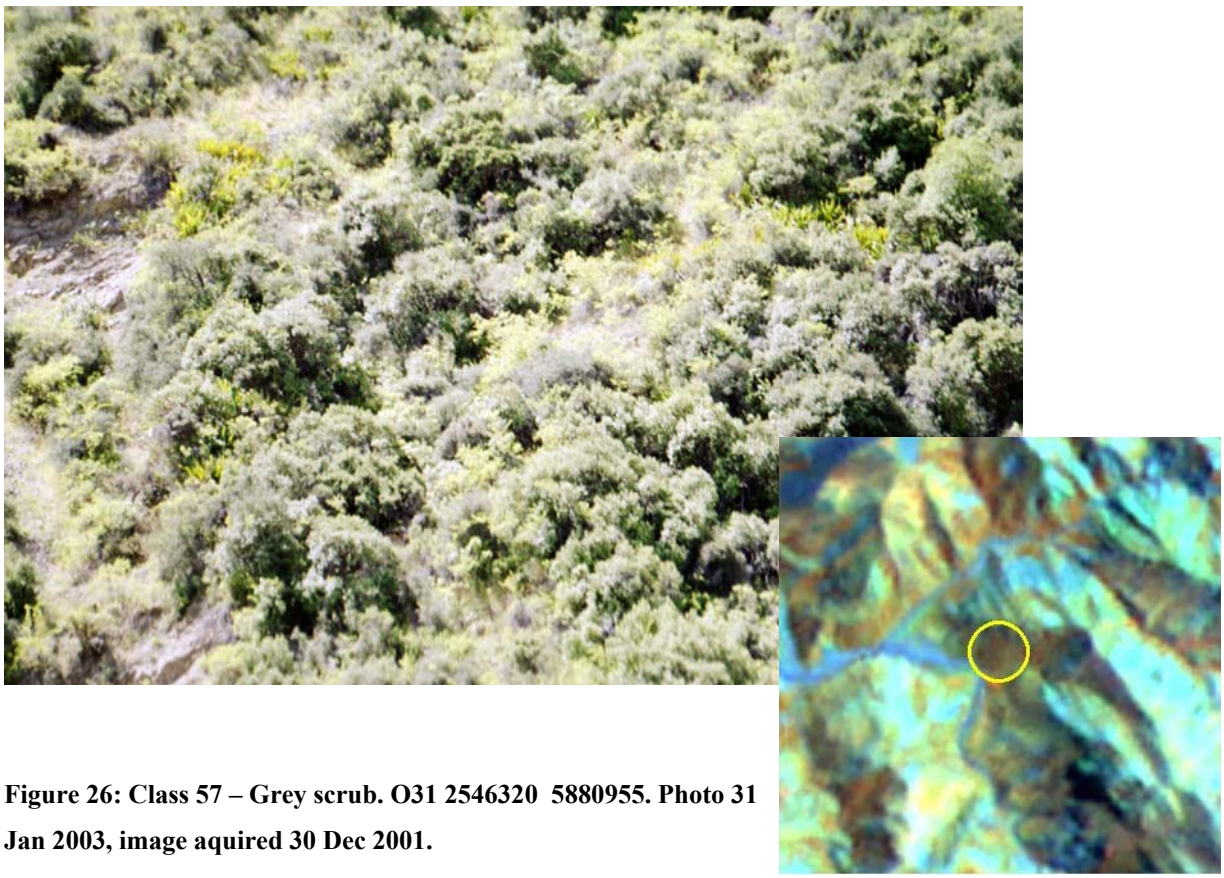


**Figure 26: Class 57 – Grey scrub. O31 2546320 5880955. Photo 31 Jan 2003, image aquired 30 Dec 2001.**

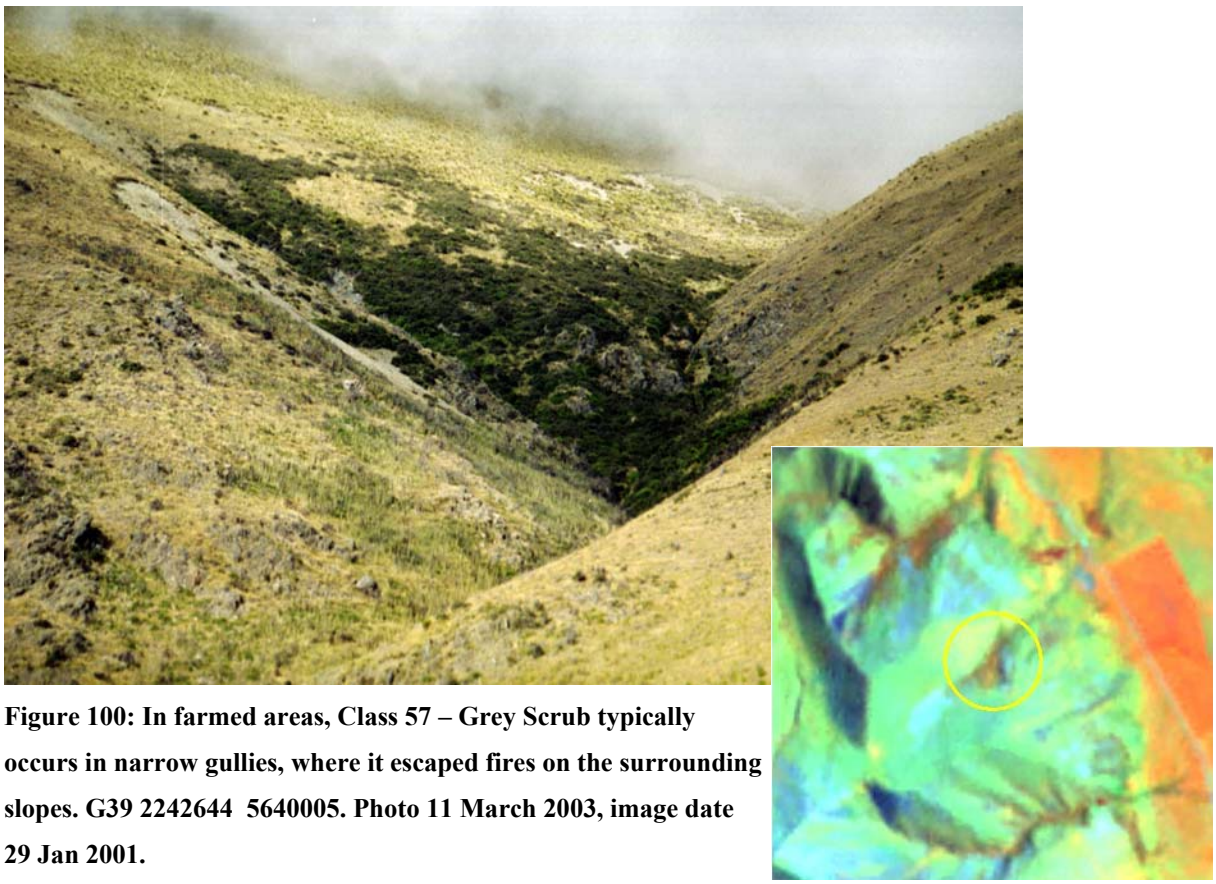
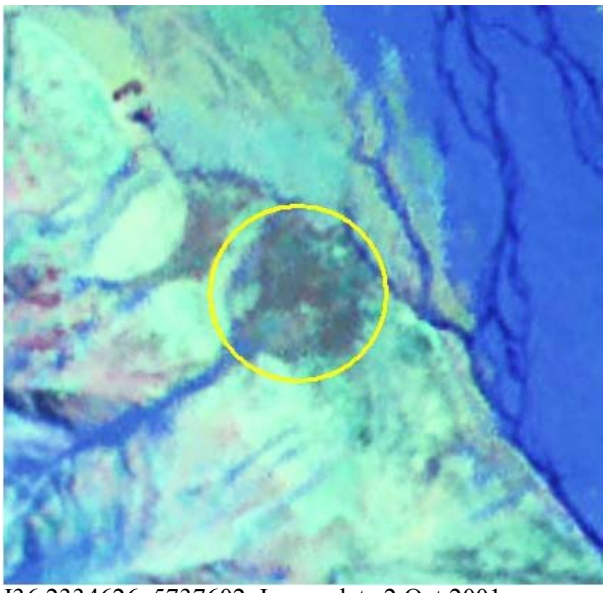
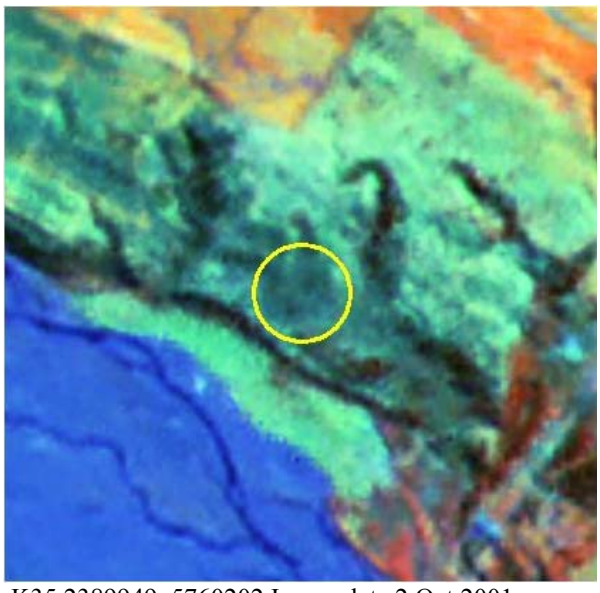


**Figure 100: In farmed areas, Class 57 – Grey Scrub typically occurs in narrow gullies, where it escaped fires on the surrounding slopes. G39 2242644 5640005. Photo 11 March 2003, image date 29 Jan 2001.**



J36 2334626 5737602. Image date 2 Oct 2001.



K35 2389949 5760202 Image date 2 Oct 2001.

**Figure 27: In less disturbed areas, i.e. away from grazing animals or fire, Class 57 – Grey Scrub also occurs on fans and hill slopes.**

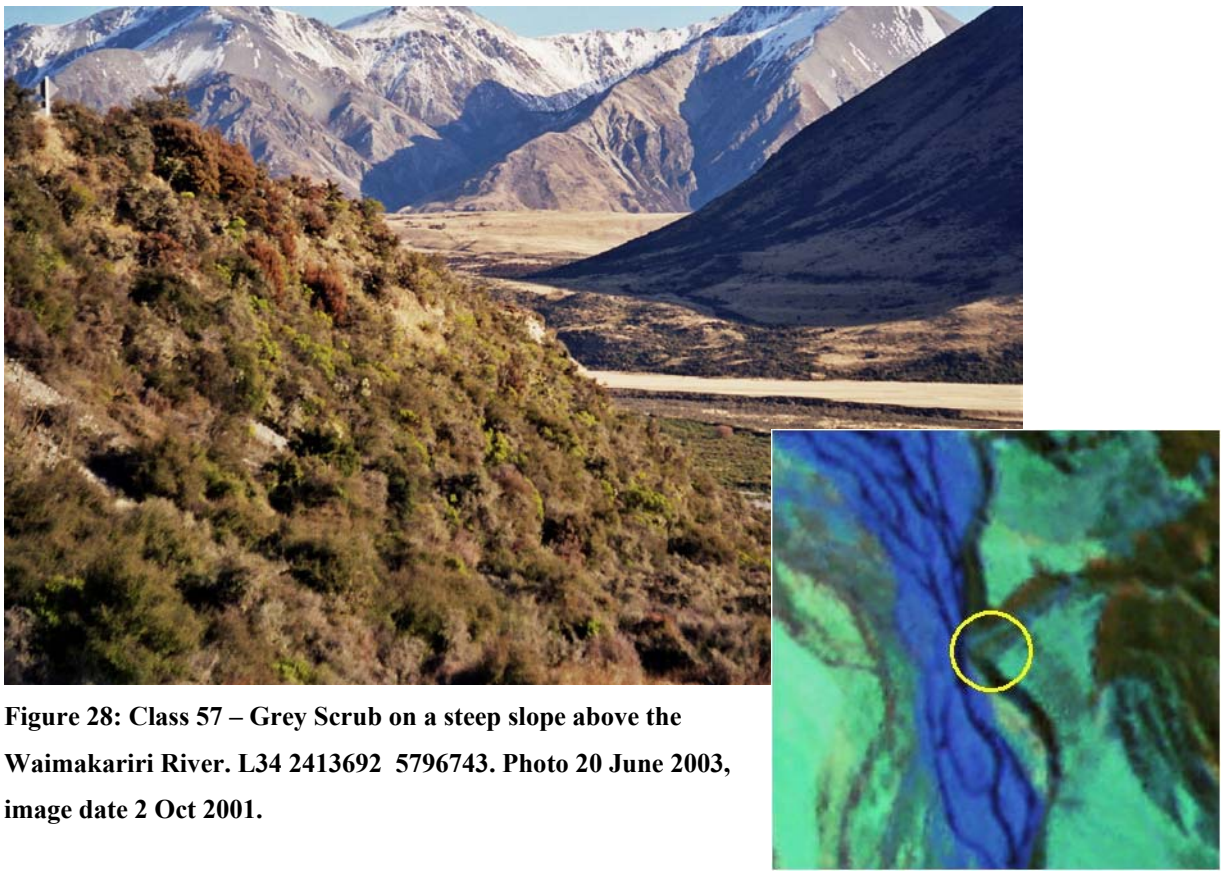


**Figure 28: Class 57 – Grey Scrub on a steep slope above the Waimakariri River. L34 2413692  5796743. Photo 20 June 2003, image date 2 Oct 2001.**

## Forest

### 60 Minor Shelterbelts:

Minor Shelterbelts are visible as linear features in the imagery. No distinction is made between evergreen or deciduous shelterbelts. Shelterbelts longer than 150 m are mapped and this class is comprised of features 1 pixel in width. However linear high biomass features such as *pinus radiata* do saturate neighbouring pixels when in fact the shelterbelt may only be 1 or 2 rows wide. The purpose of this class is to map these narrow shelterbelts. These features are released as a separate line coverage. If the signature of a shelterbelt exceeds 2 pixels it is captured as a polygon and assigned to Class 61 – Major Shelterbelts.

### 61 Major Shelterbelts:

Major Shelterbelts are visible as linear features in the imagery. No distinction is made between evergreen or deciduous shelterbelts. Major shelterbelts longer than 200 m with a signature 2 or more pixels wide are mapped as a polygon coverage.

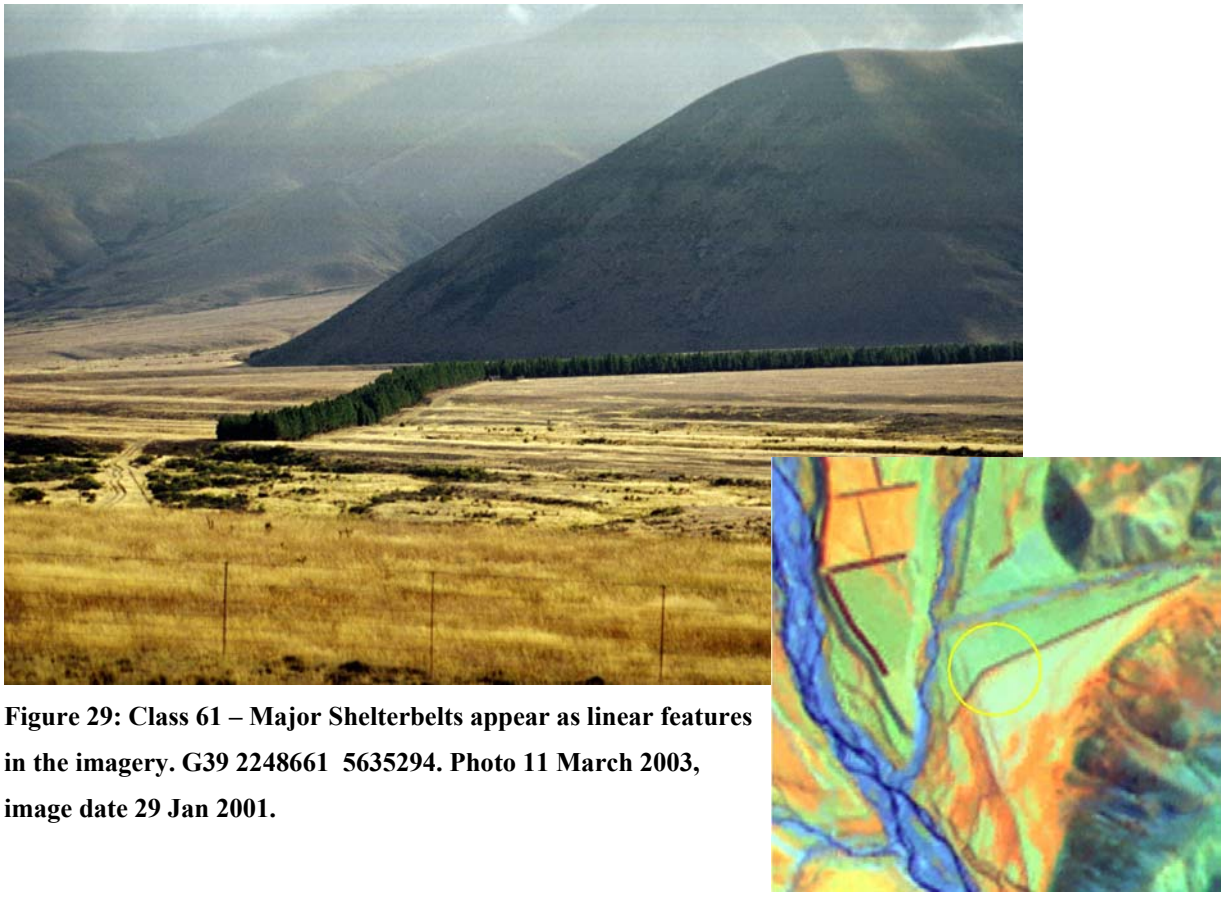


**Figure 29: Class 61 – Major Shelterbelts appear as linear features in the imagery. G39 2248661 5635294. Photo 11 March 2003, image date 29 Jan 2001.**

## 62 Afforestation (not imaged):

Areas of *pinus radiata* forest not visible in the satellite imagery, but identified during the field-checking phase, or because of contextual patterns associated with forest establishment, e.g. roading and firebreaks. Because this class is identified in a random fashion, it contains a larger error than classes identified on the images, i.e. the true area of new afforestation is likely to be larger than assessed.

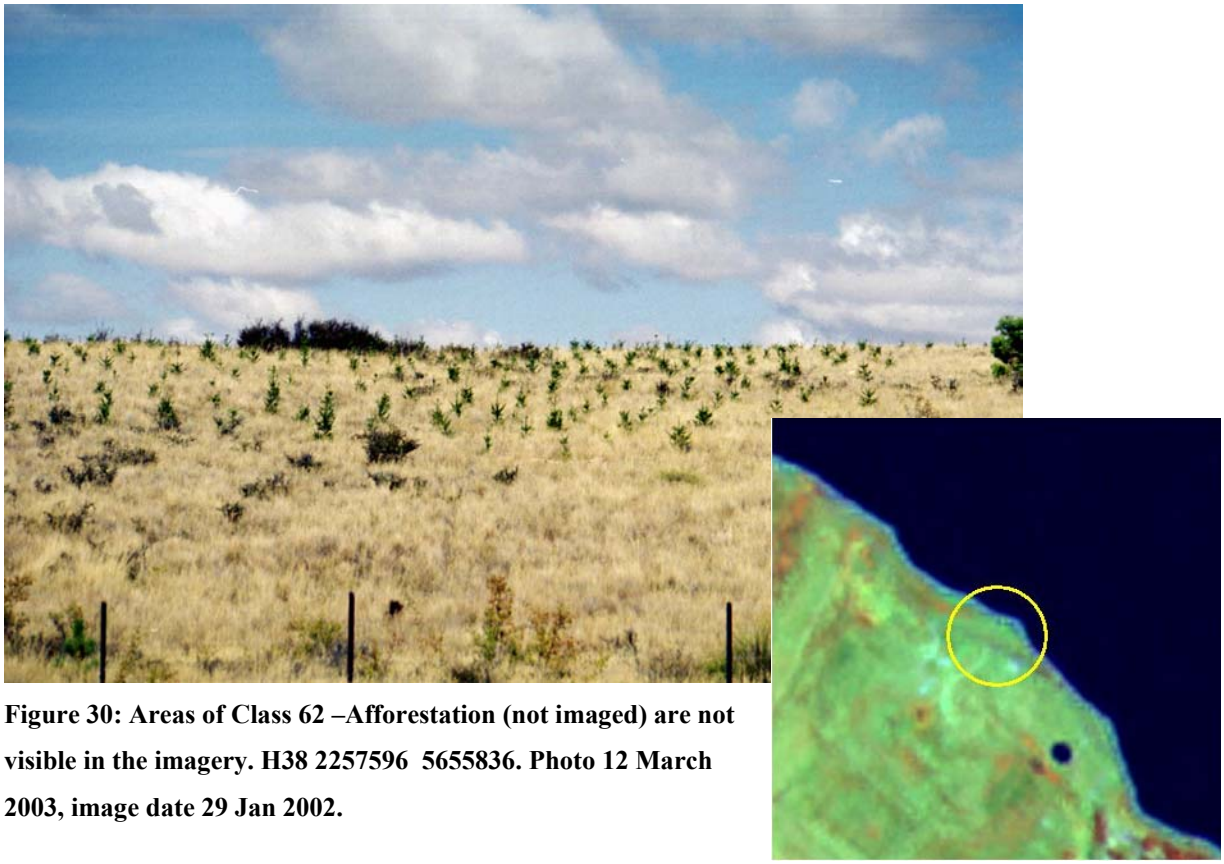


**Figure 30: Areas of Class 62 –Afforestation (not imaged) are not visible in the imagery. H38 2257596 5655836. Photo 12 March 2003, image date 29 Jan 2002.**

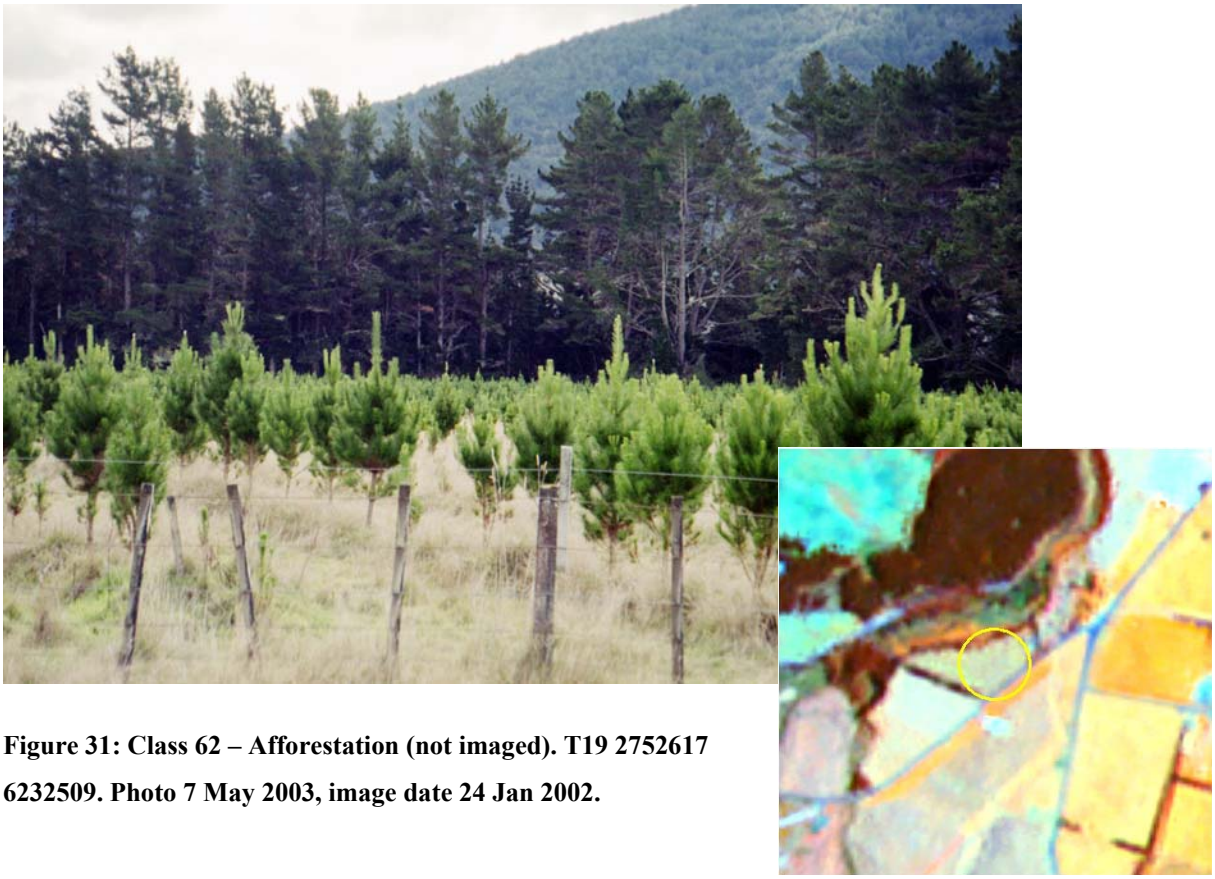


**Figure 31: Class 62 – Afforestation (not imaged). T19 2752617 6232509. Photo 7 May 2003, image date 24 Jan 2002.**

## 63 Afforestation (imaged and post-LCDB 1):

Areas of *Pinus radiata* forest visible in the imagery and located on sites recorded as non-forested in LCDB 1. These areas represent young forests that were not visible in the 1996 / 97 imagery used for LCDB 1 or have been planted since. Young plantations are identifiable in satellite imagery 4-5 years after planting, depending on initial stocking.

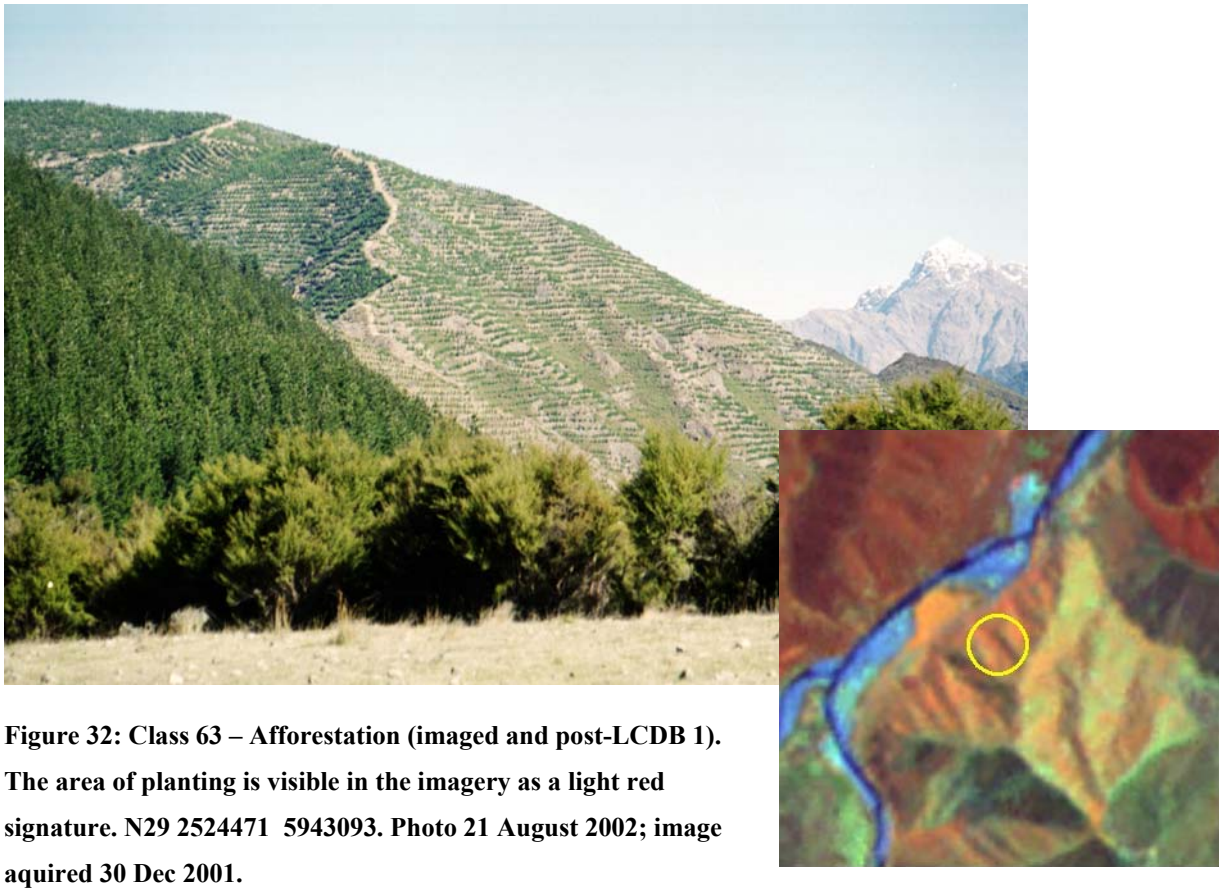


**Figure 32: Class 63 – Afforestation (imaged and post-LCDB 1). The area of planting is visible in the imagery as a light red signature. N29 2524471 5943093. Photo 21 August 2002; image aquired 30 Dec 2001.**

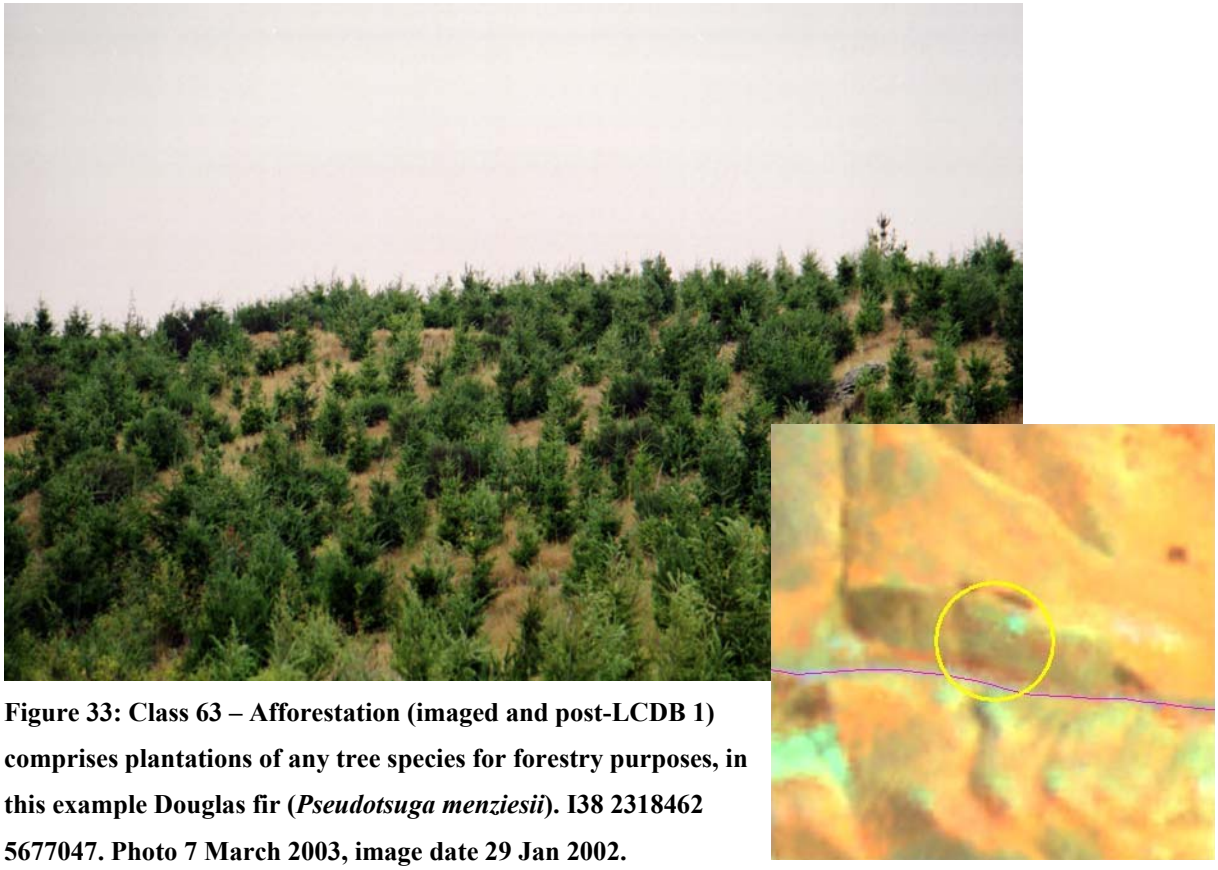


**Figure 33: Class 63 – Afforestation (imaged and post-LCDB 1) comprises plantations of any tree species for forestry purposes, in this example Douglas fir (*Pseudotsuga menziesii*). I38 2318462 5677047. Photo 7 March 2003, image date 29 Jan 2002.**

### 64 Forest - Harvested:

Areas showing evidence of harvesting since LCDB1, e.g. forest canopy openings, skidder tracking, new roading or log landings. For plantations and woodlots, the classification assumes these sites to be replanted, and this will be checked in the next iteration of the database. By this time, if the areas were replanted in plantation forest species, the trees will be at least 5 years old and identifiable. If the area was indigenous forest in LCDB1 the cleared area is mapped as class 64. The next iteration of the database will be record the actual land cover on these sites. Forest loss due to localised erosion is mapped as class 12, Landslide.

The purpose class 64 is to confirm the extent of harvested pine forest that is replanted and indigenous or exotic forest that is converted to another land cover / land use.

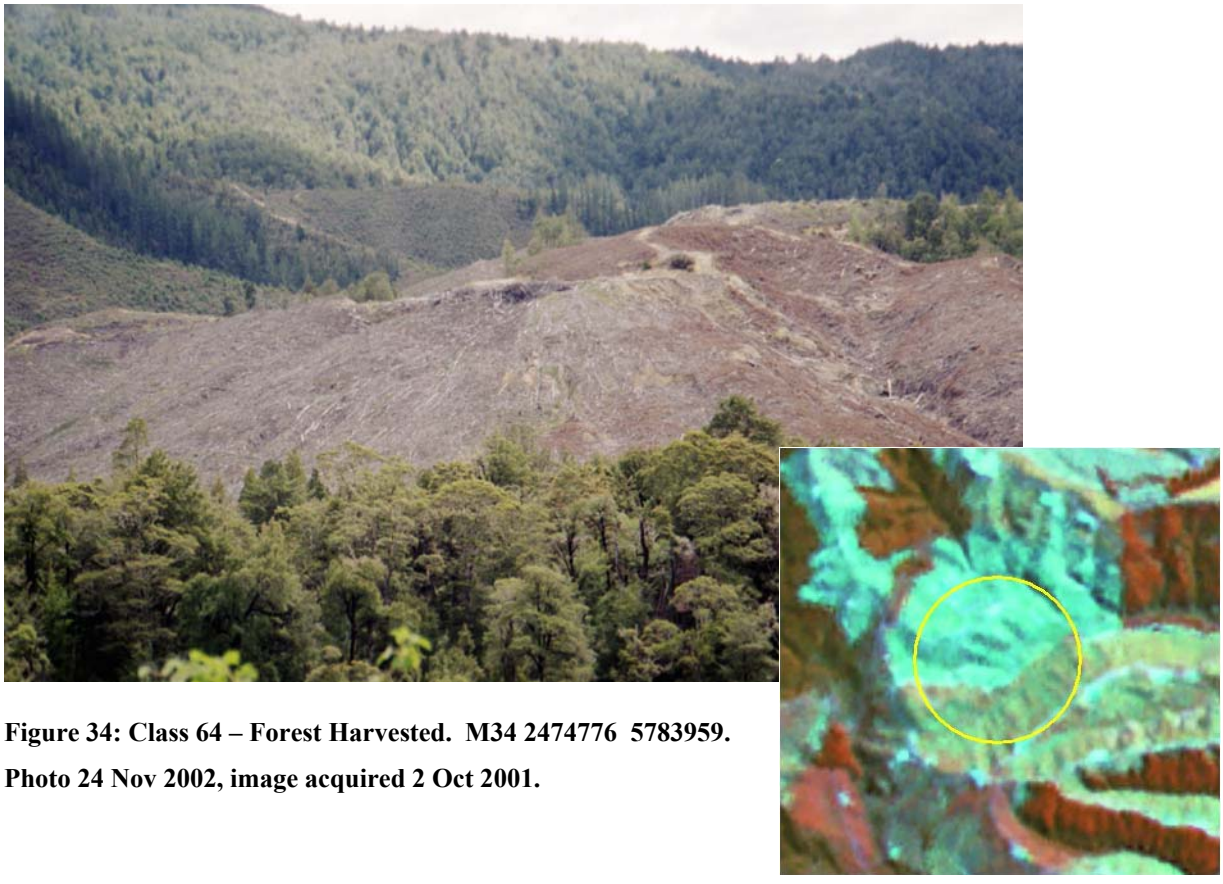


**Figure 34: Class 64 – Forest Harvested. M34 2474776 5783959. Photo 24 Nov 2002, image acquired 2 Oct 2001.**

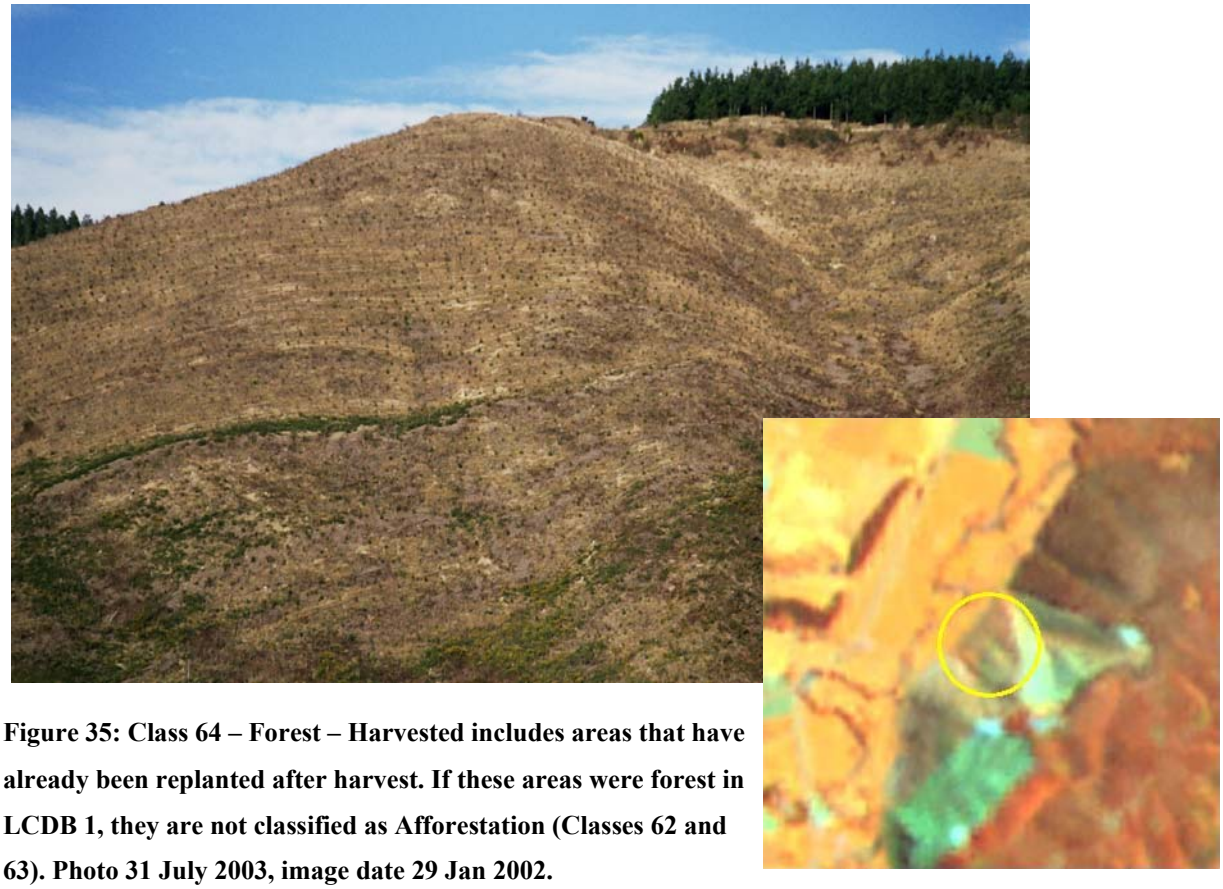


**Figure 35: Class 64 – Forest – Harvested includes areas that have already been replanted after harvest. If these areas were forest in LCDB 1, they are not classified as Afforestation (Classes 62 and 63). Photo 31 July 2003, image date 29 Jan 2002.**

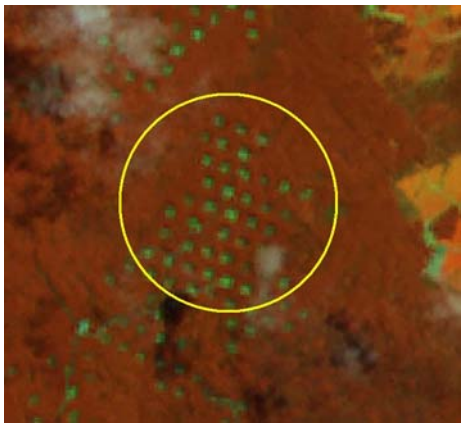


**Figure 36: Class 64 – Forest – Harvested D46 2118252 5425249. Class includes coupes of indigenous forest harvested since LCDB1. Image Date 19 December 2001.**

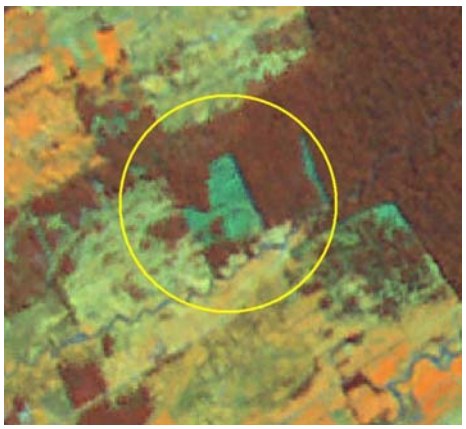


**Figure 37: Class 64 – Forest – Harvested P20 2592310 6206744. Class includes areas of indigenous forest clearfelled since LCDB1. Image Date 25 September 2001.**

## 65 Pine Forest - Open Canopy:

Plantations of *Pinus radiata* showing significant reflectance of understorey land cover. The reflectance values for stand biomass and pine canopy indicate that trees are in an age class of approximately 6 - 15 years.

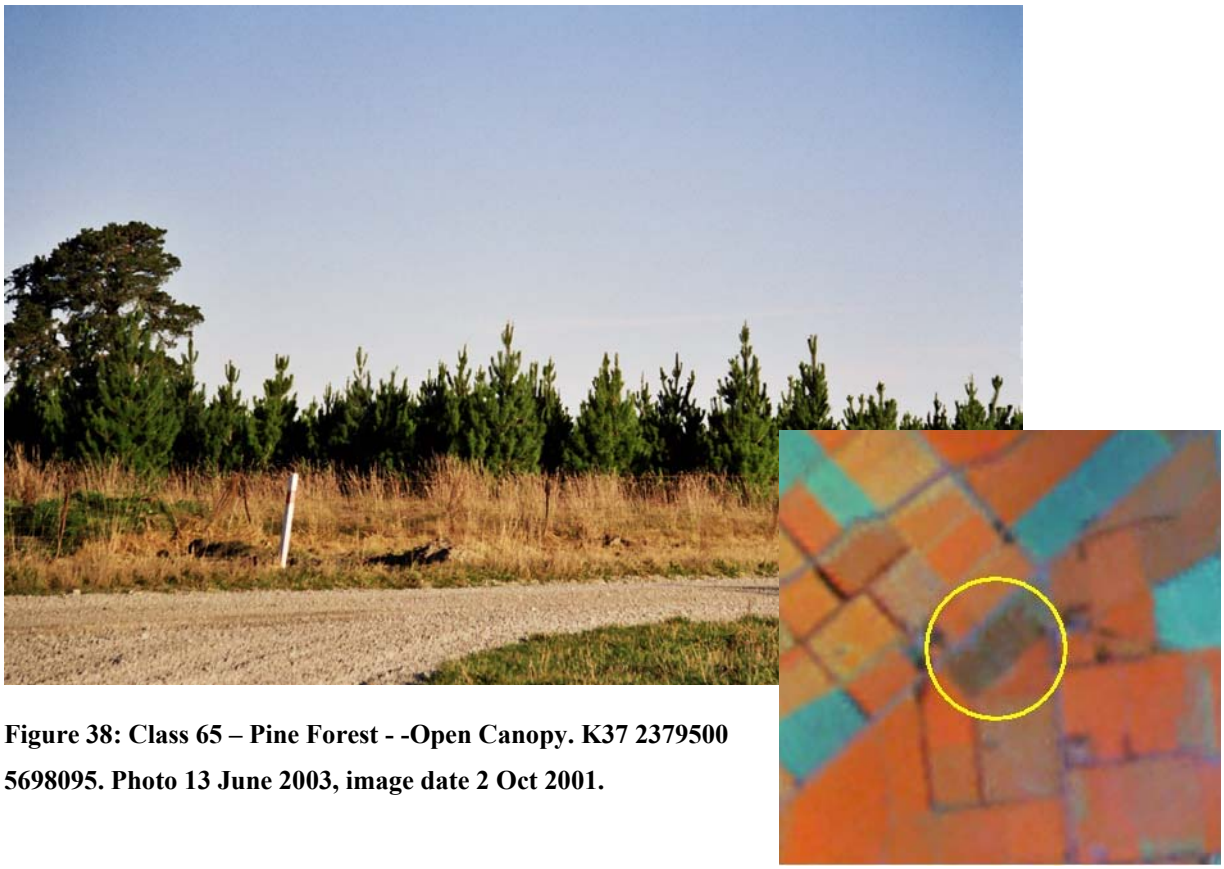


**Figure 38: Class 65 – Pine Forest - -Open Canopy. K37 2379500 5698095. Photo 13 June 2003, image date 2 Oct 2001.**

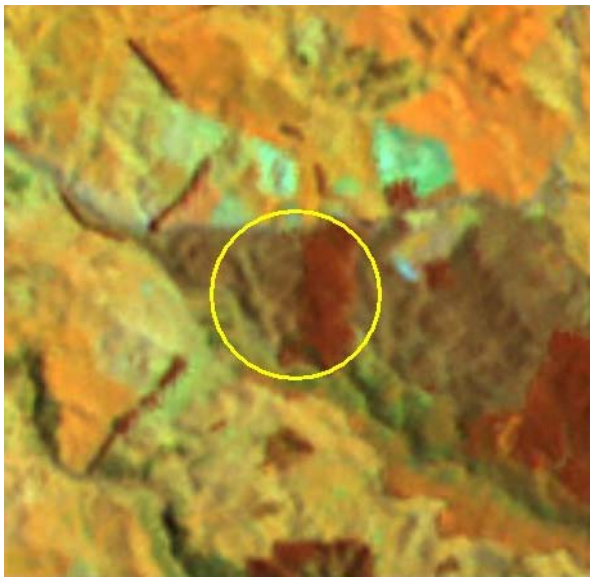


**Figure 39: The signature of open canopy pine forest can vary considerably depending on management. The trees in the left forest block have been pruned, while trees in the block to the right remained unpruned. T18 2746859 6277130. Image date 24 Jan 2002.**

### 66 Pine Forest - Closed Canopy:

Plantations of *Pinus radiata* where reflectance is dominated by the pine canopy. Reflectance values for stand biomass and shadow from canopy texture indicate that trees are likely to be older than 15 years. The purpose of this class is to highlight stands likely to be harvested within 10 - 15 years of the image date.

**Figure 40: Class 66 – Pine Forest, Closed Canopy. M34 2465233 5790503. Photo 5 June 2002; image date 2 Oct 2001.**

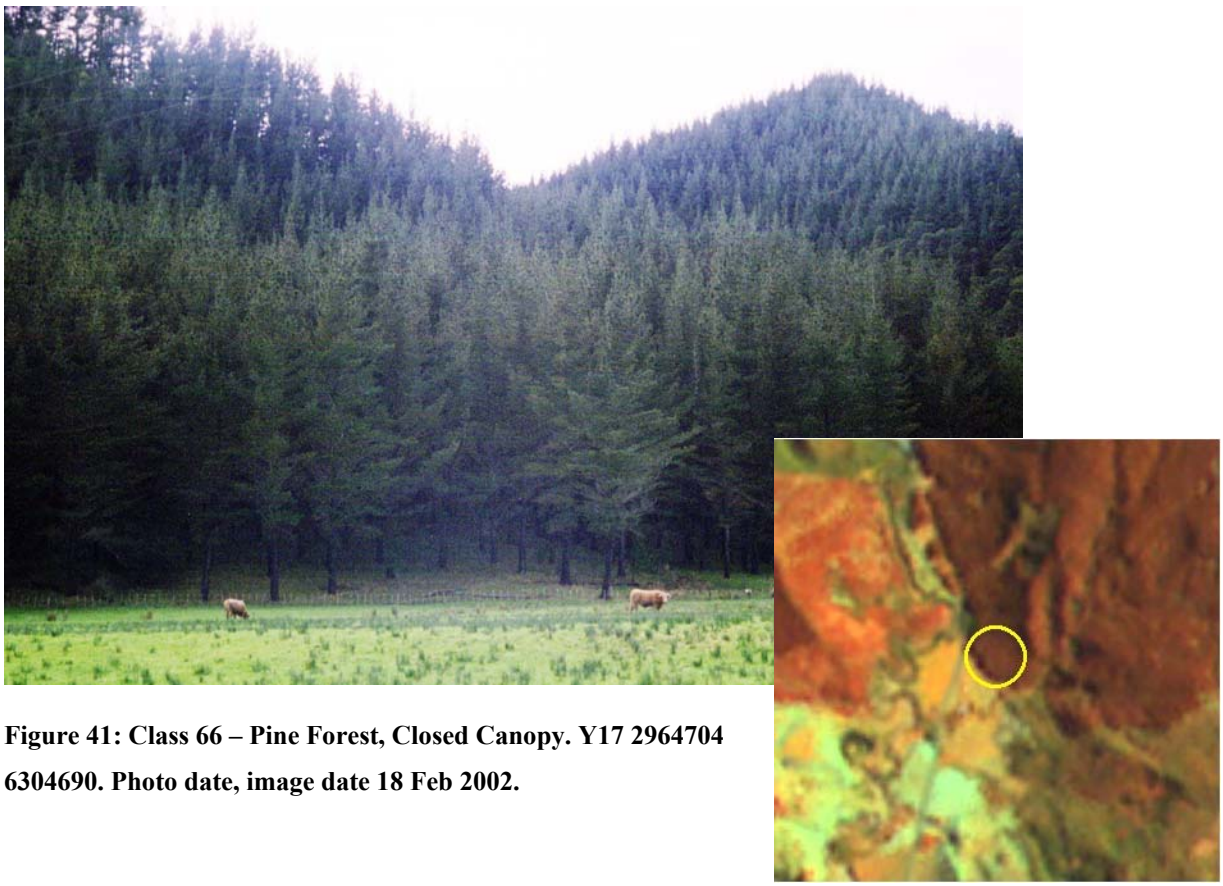


**Figure 41: Class 66 – Pine Forest, Closed Canopy. Y17 2964704 6304690. Photo date, image date 18 Feb 2002.**

## 67 Other Exotic Forest:

Exotic forest consisting of conifers other than *Pinus radiata*, such as Douglas fir, macrocarpa, and larch, or evergreen broad-leaved species, such as Acacia and Eucalyptus**.** This class also includes stands of wilding pines (i.e. usually Corsican, Contorta and Ponderosa Pine), as far as they are identifiable in the satellite imagery, i.e. stands are dense/tall enough to show a distinct signature.

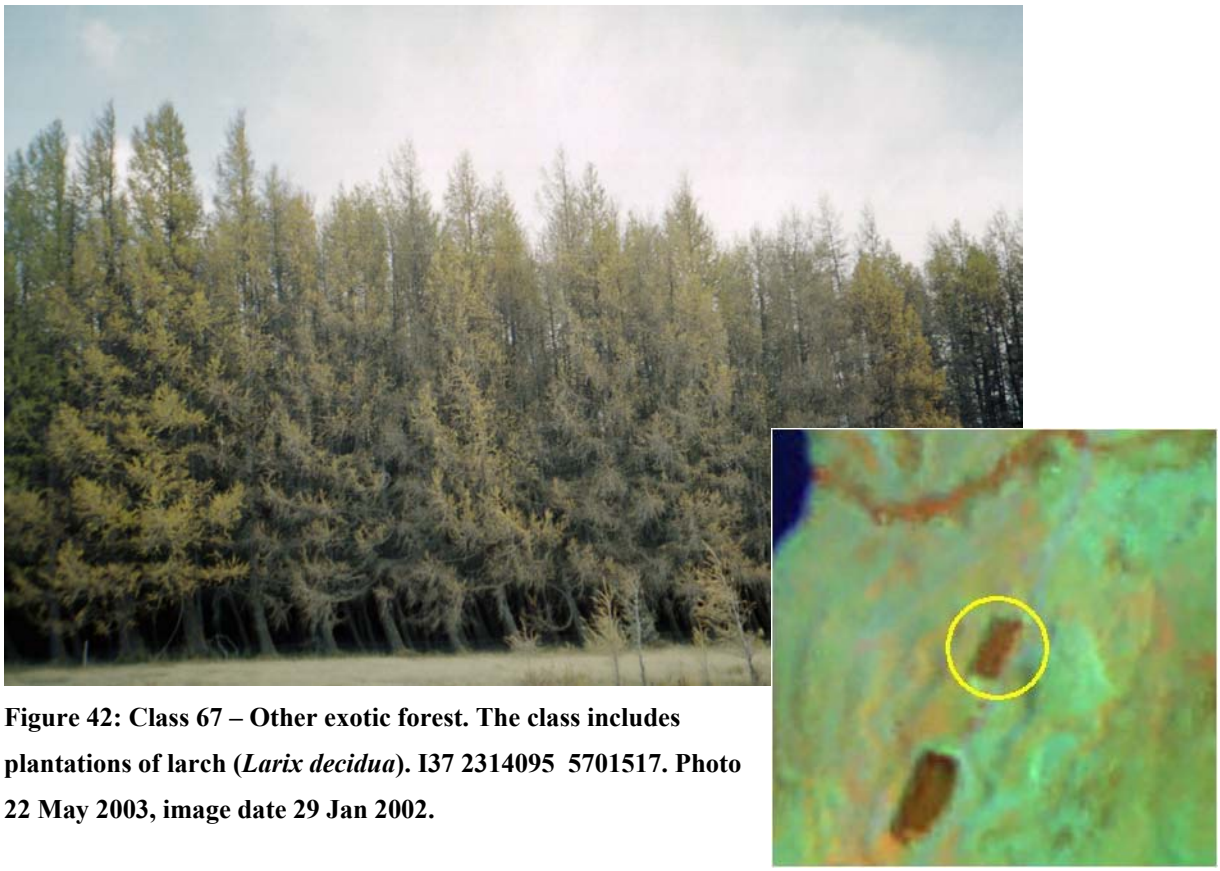


**Figure 42: Class 67 – Other exotic forest. The class includes plantations of larch (*Larix decidua*). I37 2314095 5701517. Photo 22 May 2003, image date 29 Jan 2002.**

**Figure 43: Class 67 – Other Exotic Forest includes plantations of Douglas fir (*Pseudotsuga menziesii*). The signature this species shows is bright red. J39 2346393  5627006. Photo 15 July 2003, image date 29 Jan 2002.**

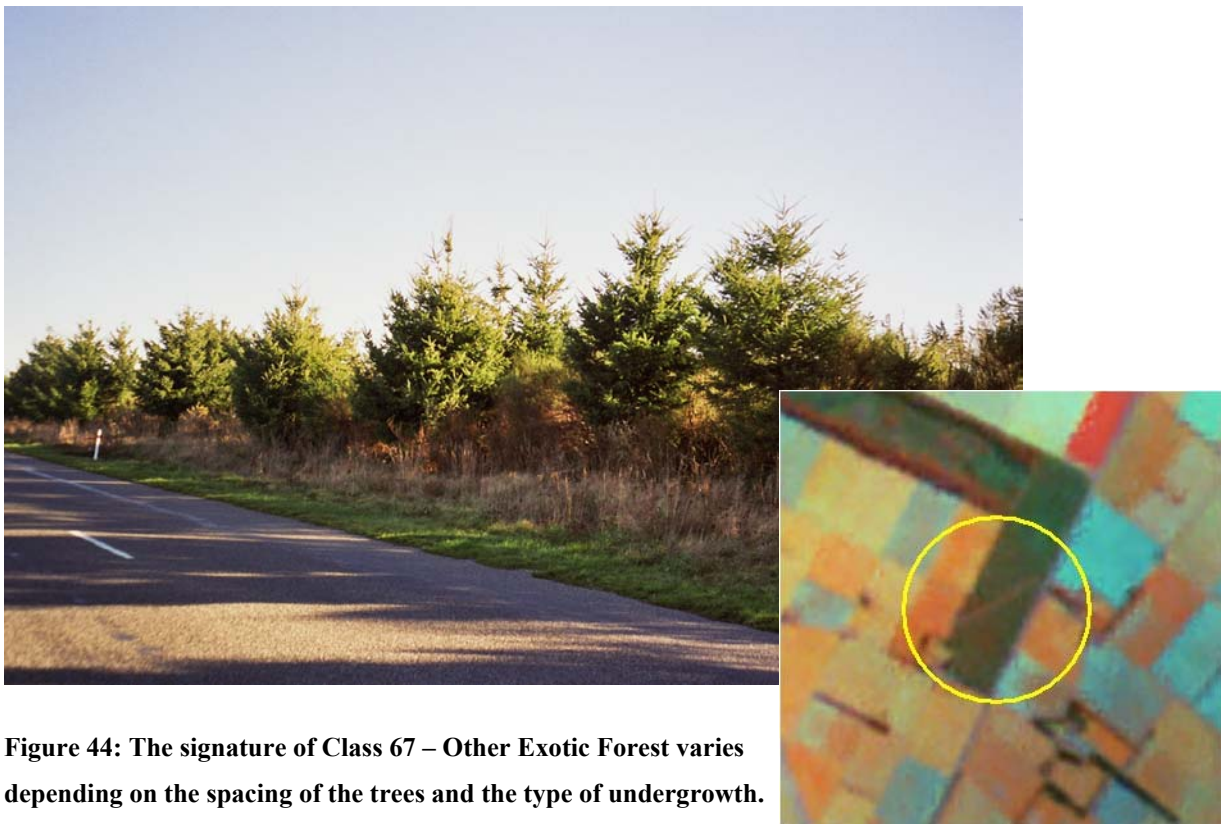


**Figure 44: The signature of Class 67 – Other Exotic Forest varies depending on the spacing of the trees and the type of undergrowth. In this example, Douglas fir (*Pseudotsuga menziesii*) are planted with wide spacing into a matrix of broom, saturating the typically bright red signature of the trees to a dark green.**

### 68 Deciduous Hardwoods:

Typically willow and poplar species growing adjacent to inland water and rivers, this class also includes stands of planted exotic deciduous hardwoods, such as oak (*Quercus* spp.*),* ash *(Fraxinus excelsior)* and elm *(Ulmus* spp.*)*.

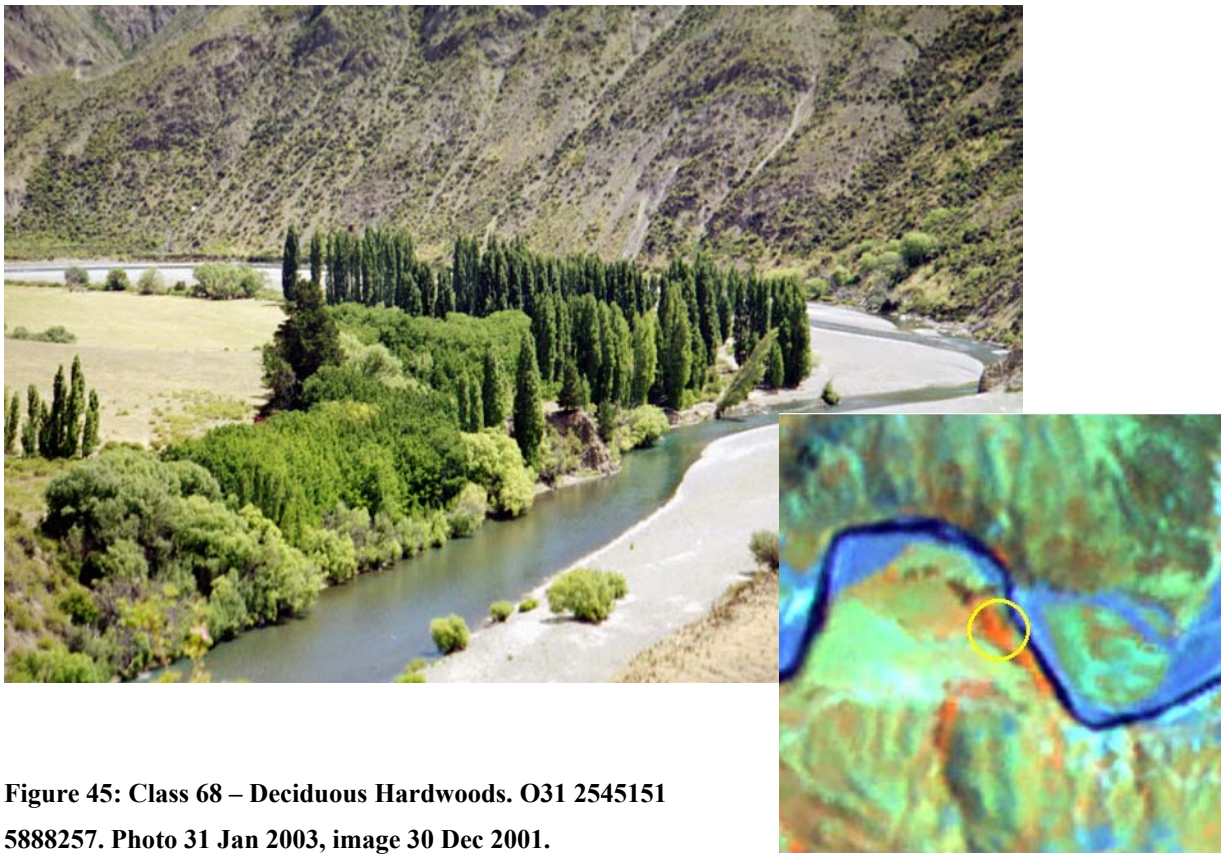


**Figure 45: Class 68 – Deciduous Hardwoods. O31 2545151 5888257. Photo 31 Jan 2003, image 30 Dec 2001.**

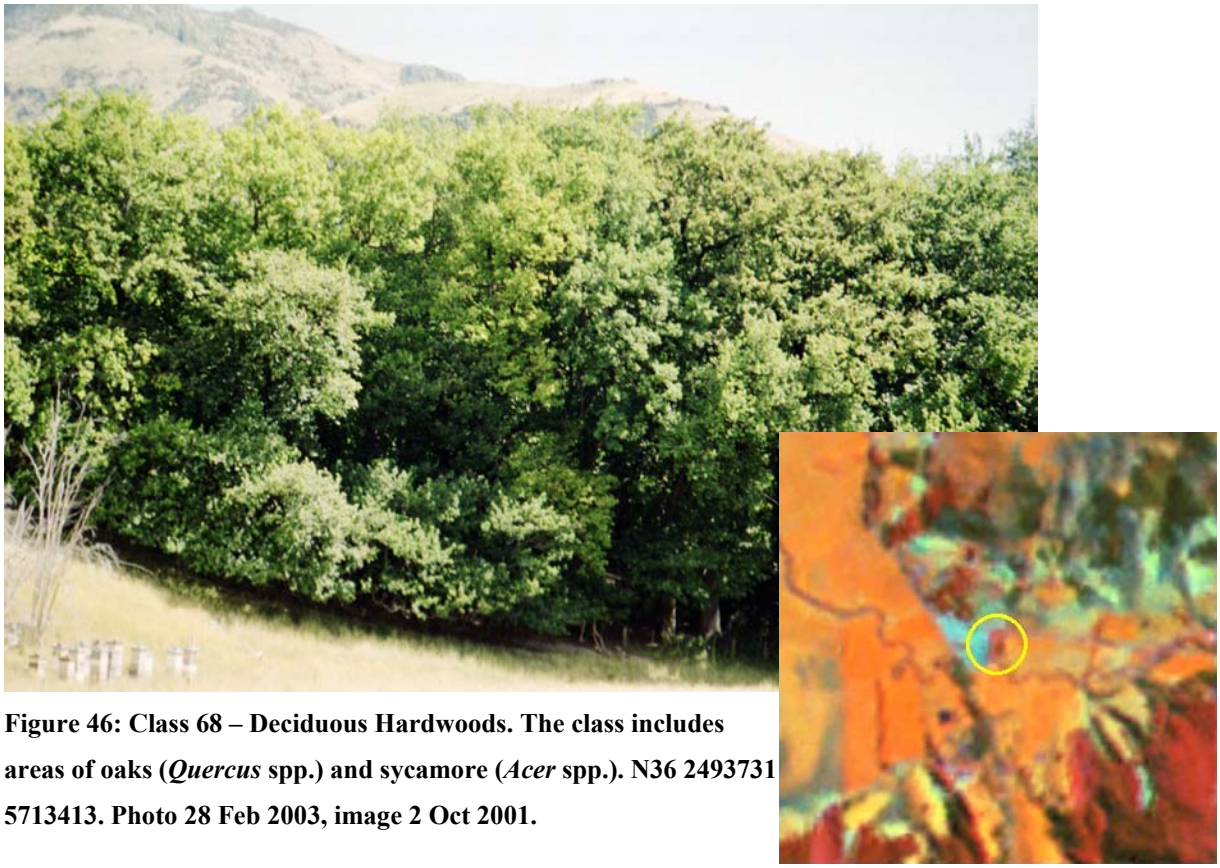


**Figure 46: Class 68 – Deciduous Hardwoods. The class includes areas of oaks (*Quercus* spp.) and sycamore (*Acer* spp.). N36 2493731 5713413. Photo 28 Feb 2003, image 2 Oct 2001.**

**Figure 47: Class 68 – Deciduous Hardwoods. The signature shows a dark green when the trees are without leaves at the time of image acquisition. R13 2669237  6428470. Photo date, image 25 Sept 2001.**

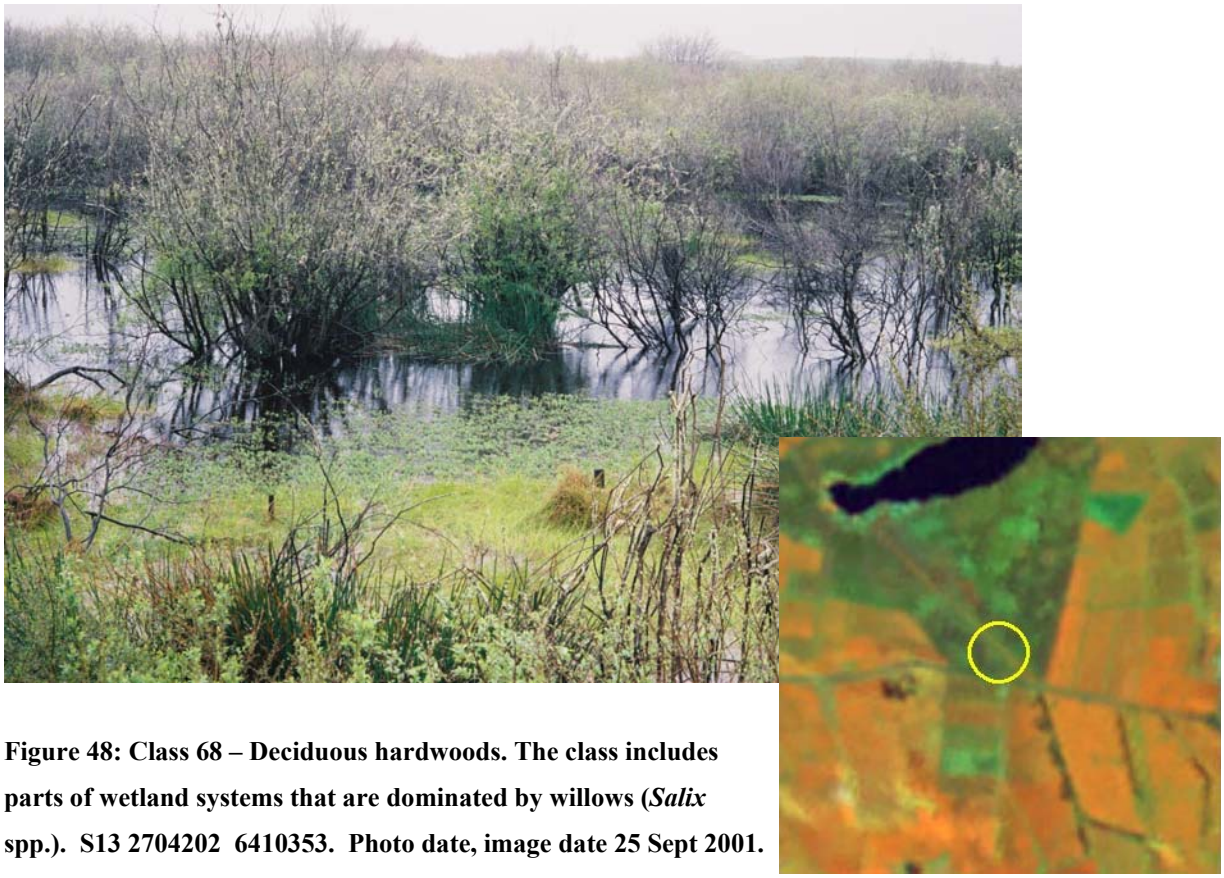


**Figure 48: Class 68 – Deciduous hardwoods. The class includes parts of wetland systems that are dominated by willows (*Salix* spp.). S13 2704202 6410353. Photo date, image date 25 Sept 2001.**

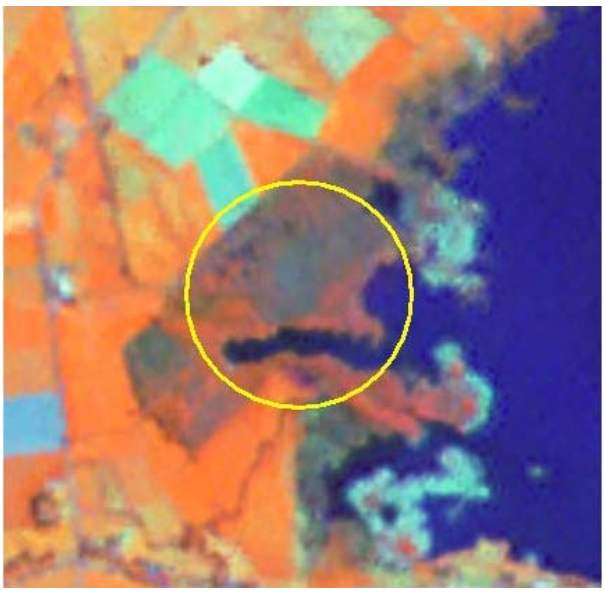


**Figure 49: Class 68 – Deciduous Hardwoods. The signature varies depending on the moisture content of the soil. The dark grey areas in this image reflect willows on water saturated ground, while the red signature reflects willows on drier ground. M36 2457591 5713172. Image date 2 Oct 2001.**

**69 Indigenous Forest:**

Classification of indigenous forest classes using satellite imagery has not been attempted for LCDB2. A national programme establishing permanent plots throughout all indigenous forest and scrub mapped in LCDB1, began in 2002. Ground data from this programme and other survey records may be used to update indigenous forest classes at a later date. Indigenous forest is defined as vegetation dominated by indigenous tall forest canopy species.

**Figure 50: Pure stands of kauri (*Agathis australis*) show a signature very similar to that of closed canopy *Pinus radiata* forest (Class 66). R11 2653205 6474679. Photo 6 July 2003, image date 11 Oct 2001.**

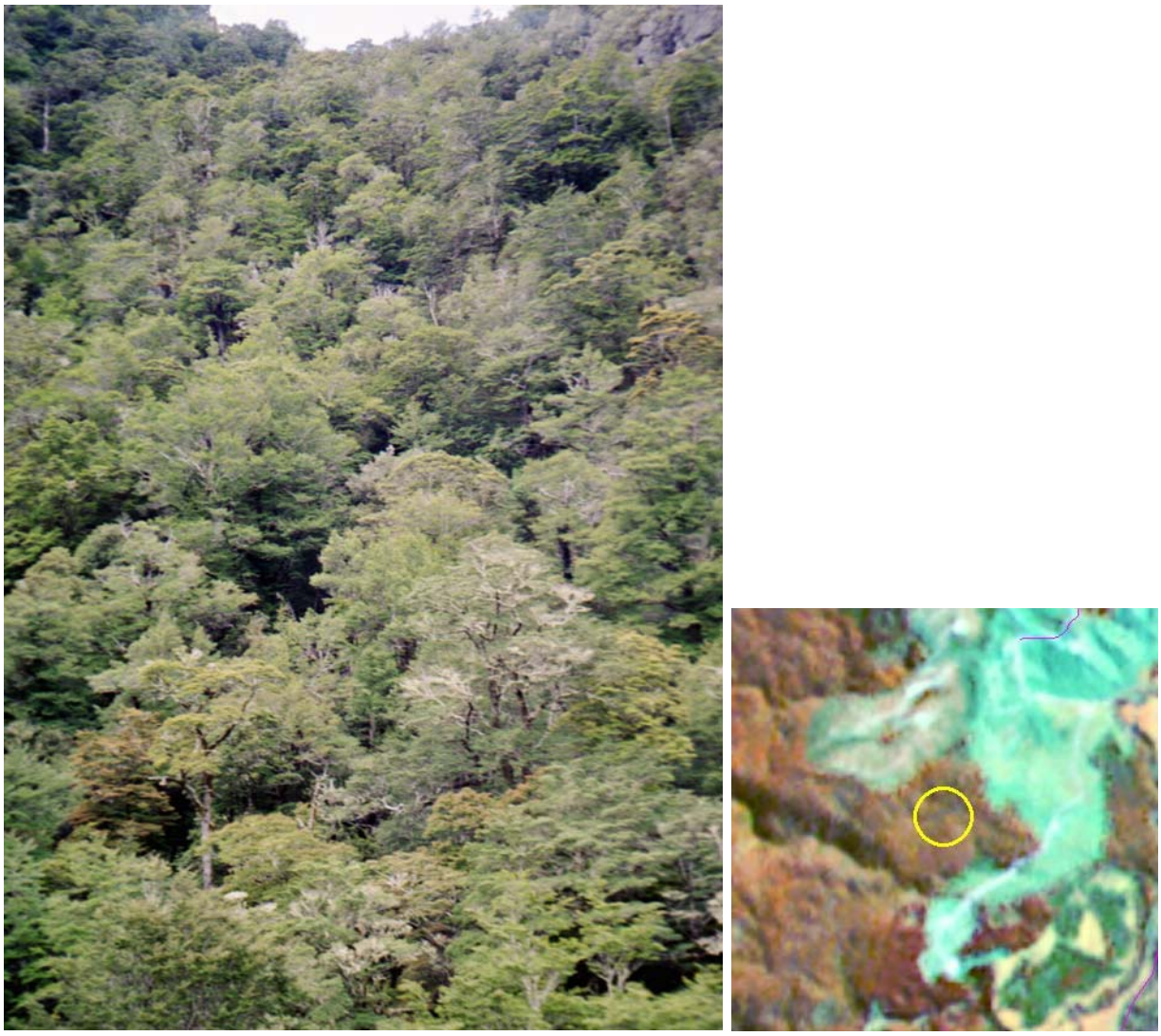


**Figure 51: Beech forest. M28 83448  60990. Photo 12 Nov 2002; image date 2 Oct 2001.**

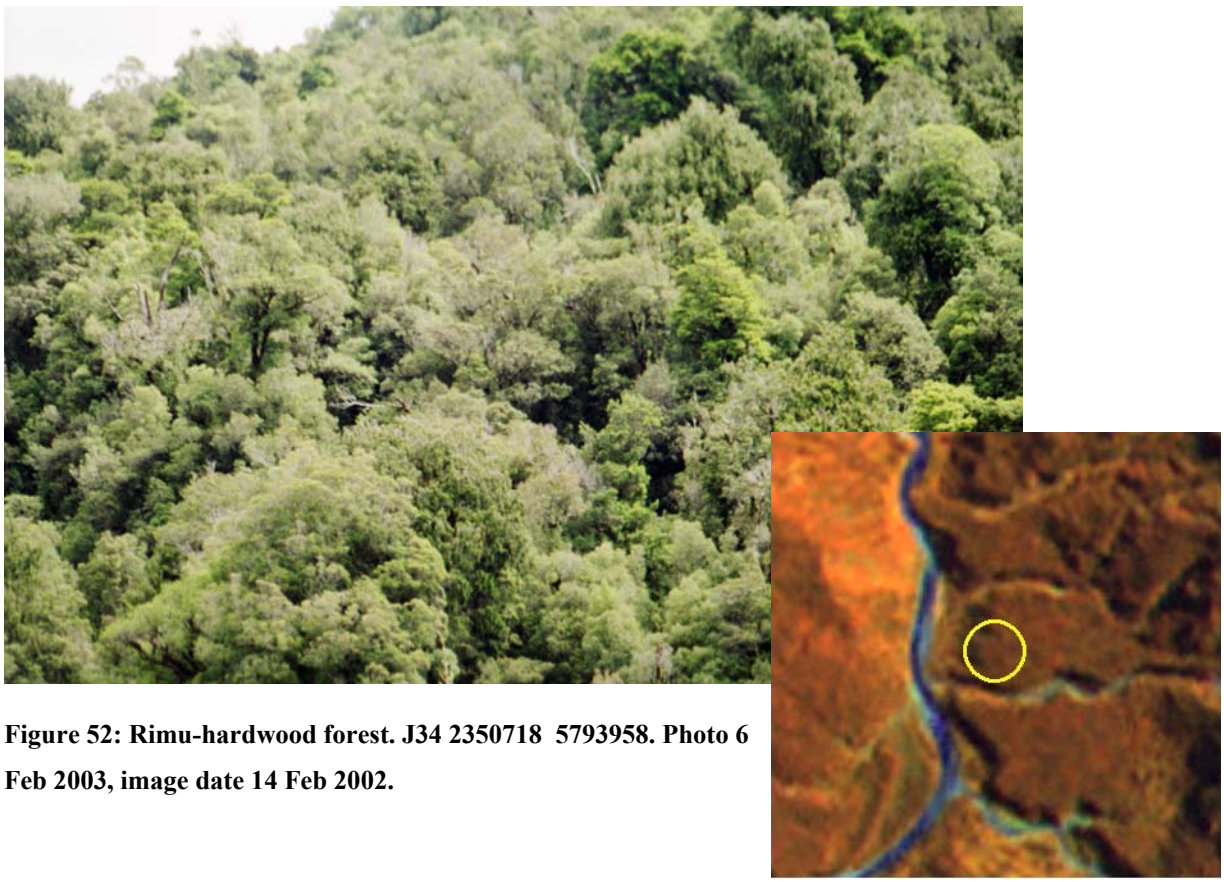


**Figure 52: Rimu-hardwood forest. J34 2350718 5793958. Photo 6 Feb 2003, image date 14 Feb 2002.**

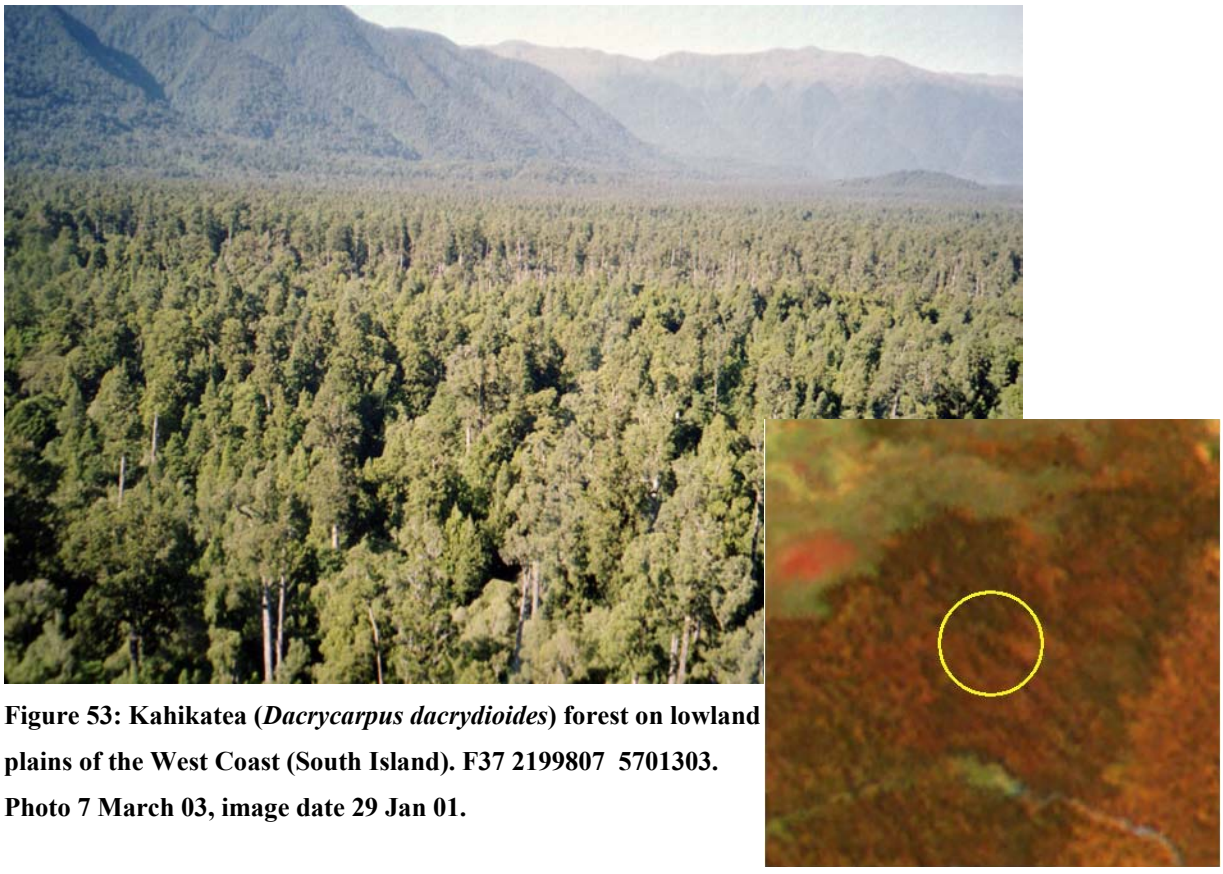


**Figure 53: Kahikatea (*Dacrycarpus dacrydioides*) forest on lowland plains of the West Coast (South Island). F37 2199807 5701303. Photo 7 March 03, image date 29 Jan 01.**

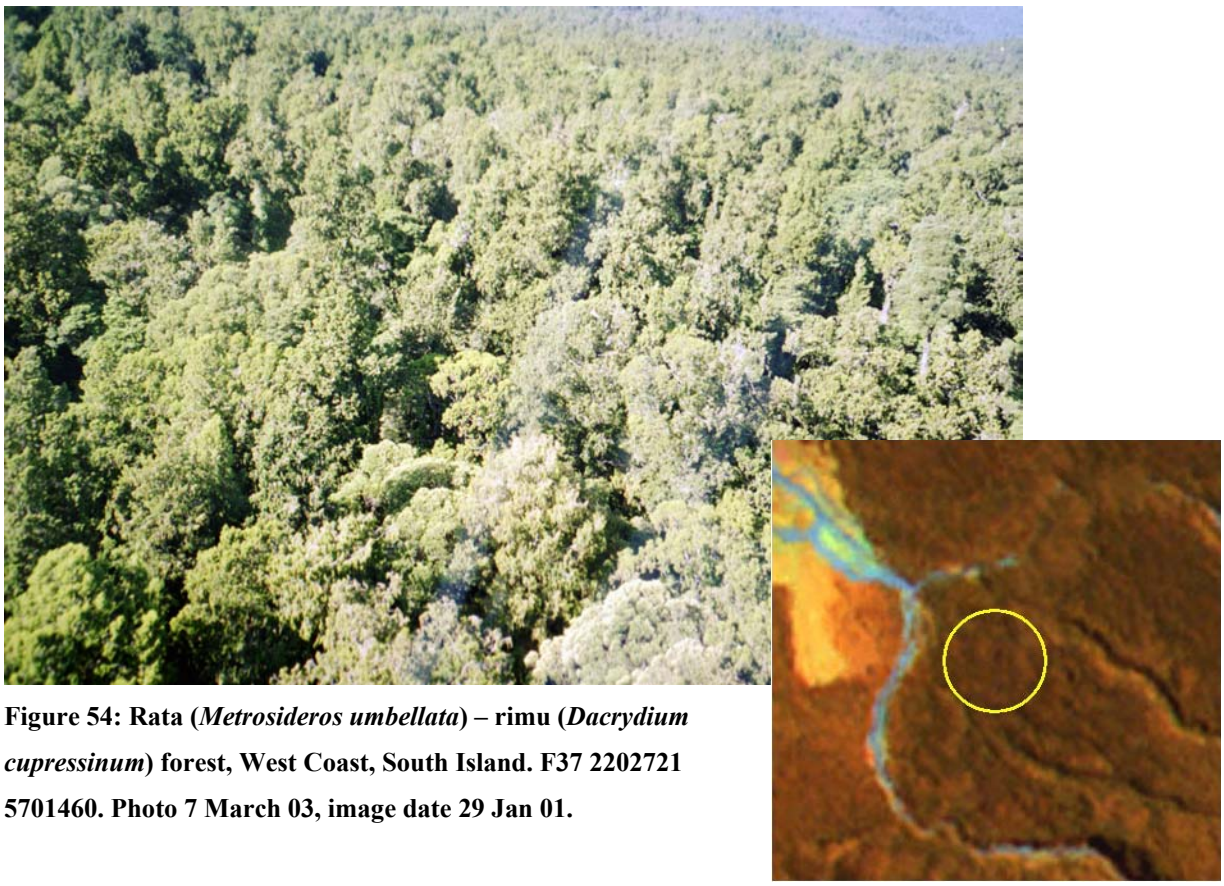


**Figure 54: Rata (*Metrosideros umbellata*) – rimu (*Dacrydium cupressinum*) forest, West Coast, South Island. F37 2202721 5701460. Photo 7 March 03, image date 29 Jan 01.**

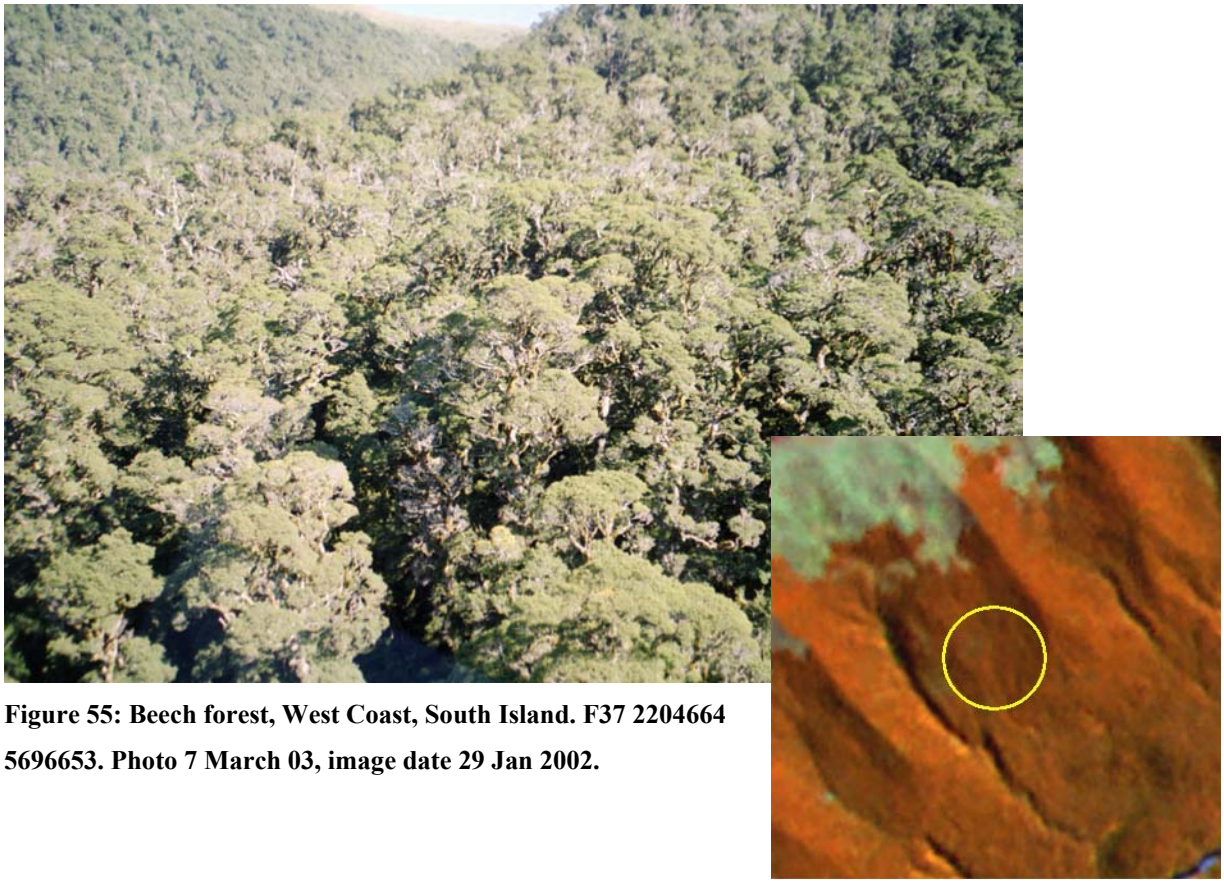


**Figure 55: Beech forest, West Coast, South Island. F37 2204664 5696653. Photo 7 March 03, image date 29 Jan 2002.**

**Figure 56: Mixed podocarp-hardwood forest in the Auckland area. R10 2655925  6516225. Photo 25 June 2003, image date 11 Oct 2001.**

### 70 Mangrove:

Mangrove (*Avicenna officinalis*) communities found on estuarine mudflats and tidal creeks. Distribution is restricted to upper North Island northward of latitude 38°. Canopy height can reach 7m reducing to 1m in the southern range of the distribution.

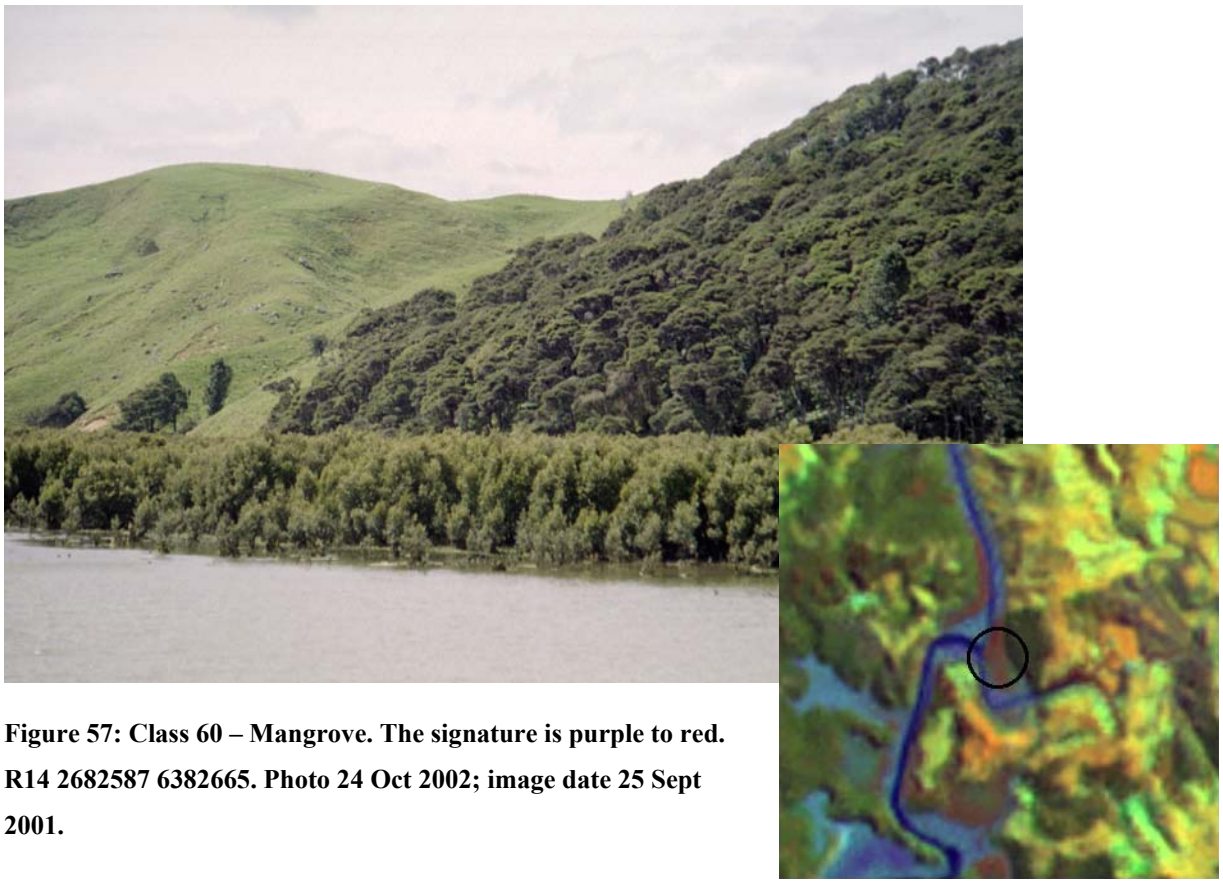


**Figure 57: Class 60 – Mangrove. The signature is purple to red. R14 2682587 6382665. Photo 24 Oct 2002; image date 25 Sept 2001.**

**Unclassified:**

Land area that cannot be allocated to any of the target land cover classes due to areas within imagery that are obscured by cloud and the area could not be "infilled" with another image source or field verified. All areas initially unclassified have been classified using aerial photography or field inspection. The database is complete.

**Other**

Other land cover classes have been developed as required to meet classification requirements for offshore Islands. For example, Peat Shrubland and Dune Shrubland communities on the Chatham Islands.

## WETLANDS

LCDB2 does not contain a class describing wetland extent, as wetlands are usually complex *systems* consisting of a number of different land cover classes, e.g., a single freshwater wetland can comprise areas of open water classed as Lakes and Ponds, areas of Herbaceous Freshwater Vegetation, Flaxland, and areas classified into one of the scrub classes. Defining the *extent* of wetland systems will require further spatial analysis and subsequent grouping of the appropriate land cover components.

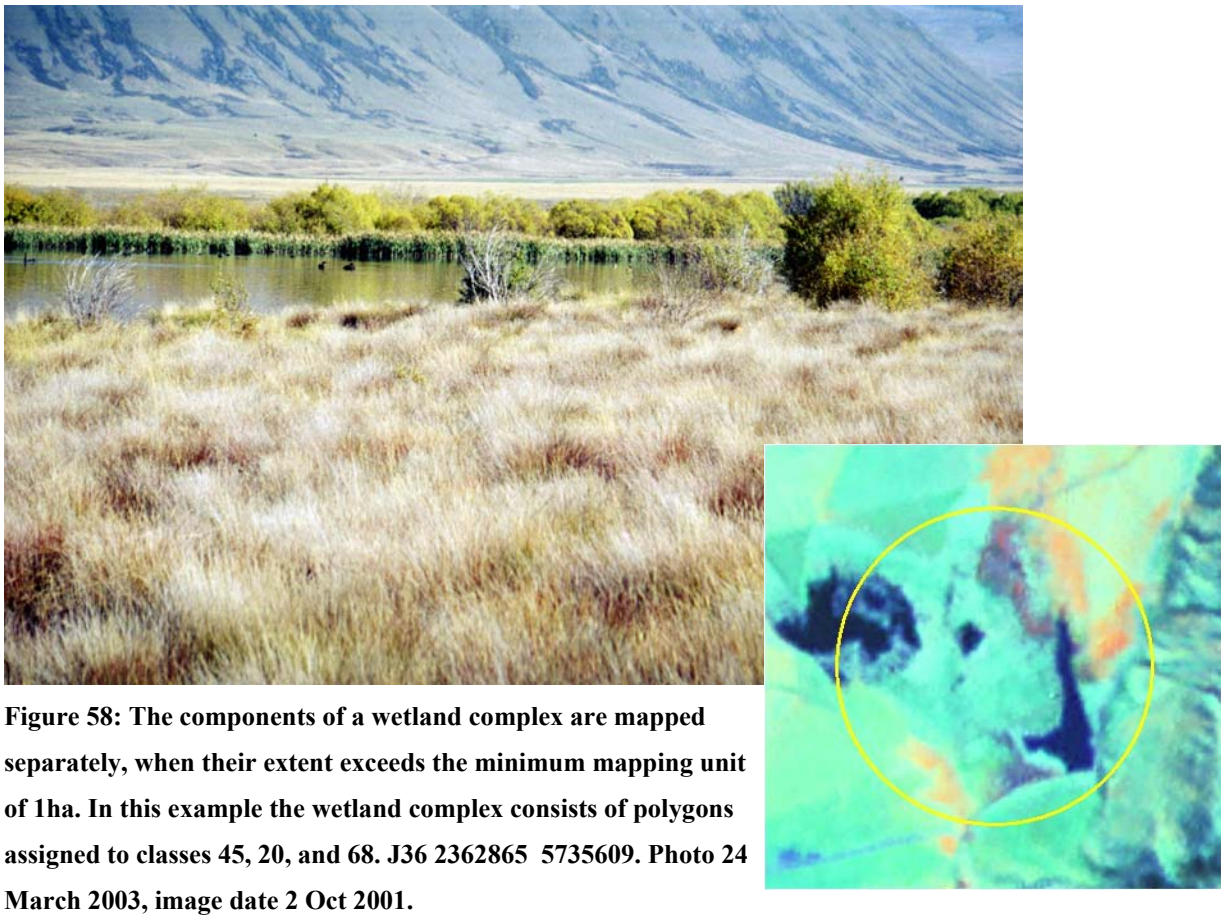


**Figure 58: The components of a wetland complex are mapped separately, when their extent exceeds the minimum mapping unit of 1ha. In this example the wetland complex consists of polygons assigned to classes 45, 20, and 68. J36 2362865 5735609. Photo 24 March 2003, image date 2 Oct 2001.**

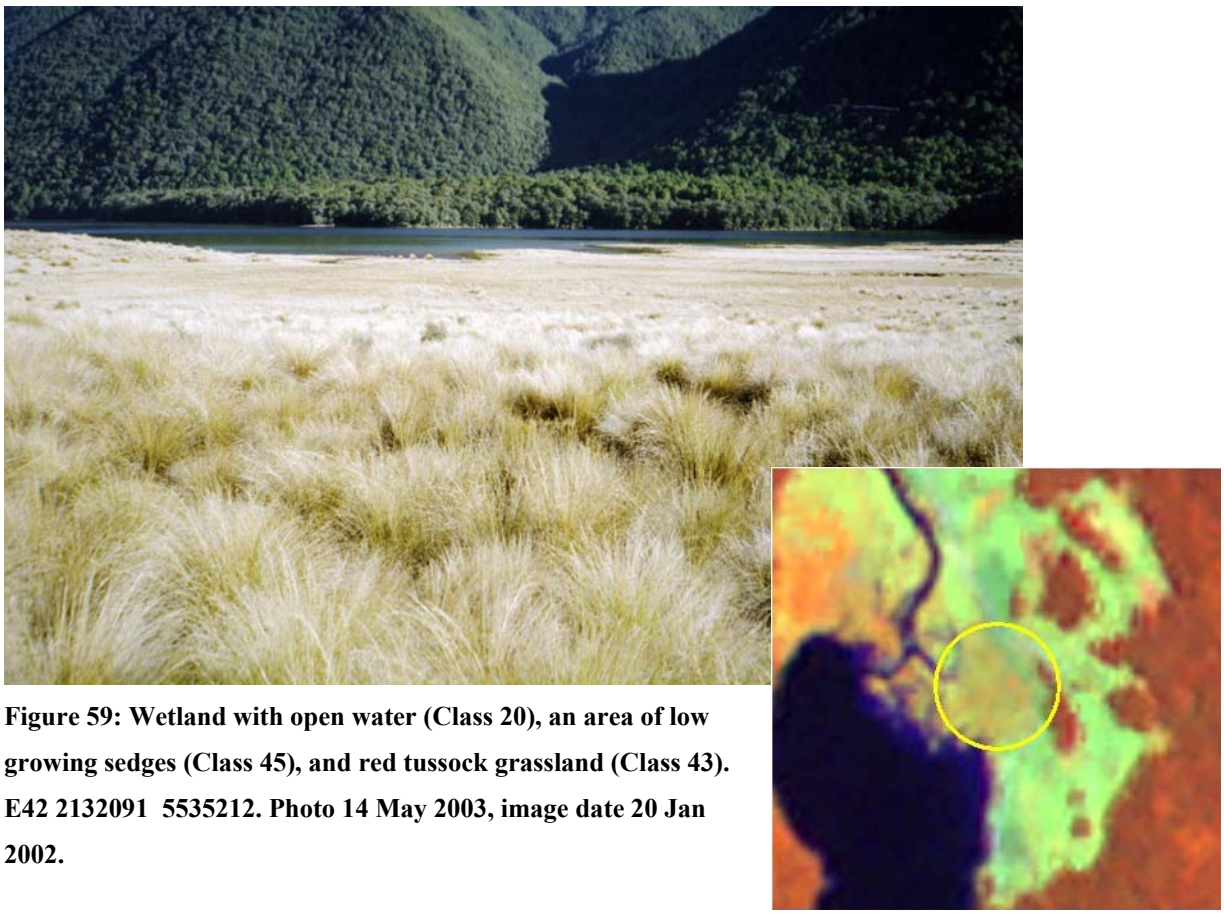


**Figure 59: Wetland with open water (Class 20), an area of low growing sedges (Class 45), and red tussock grassland (Class 43). E42 2132091  5535212. Photo 14 May 2003, image date 20 Jan 2002.**

## CONTEXT EXAMPLES

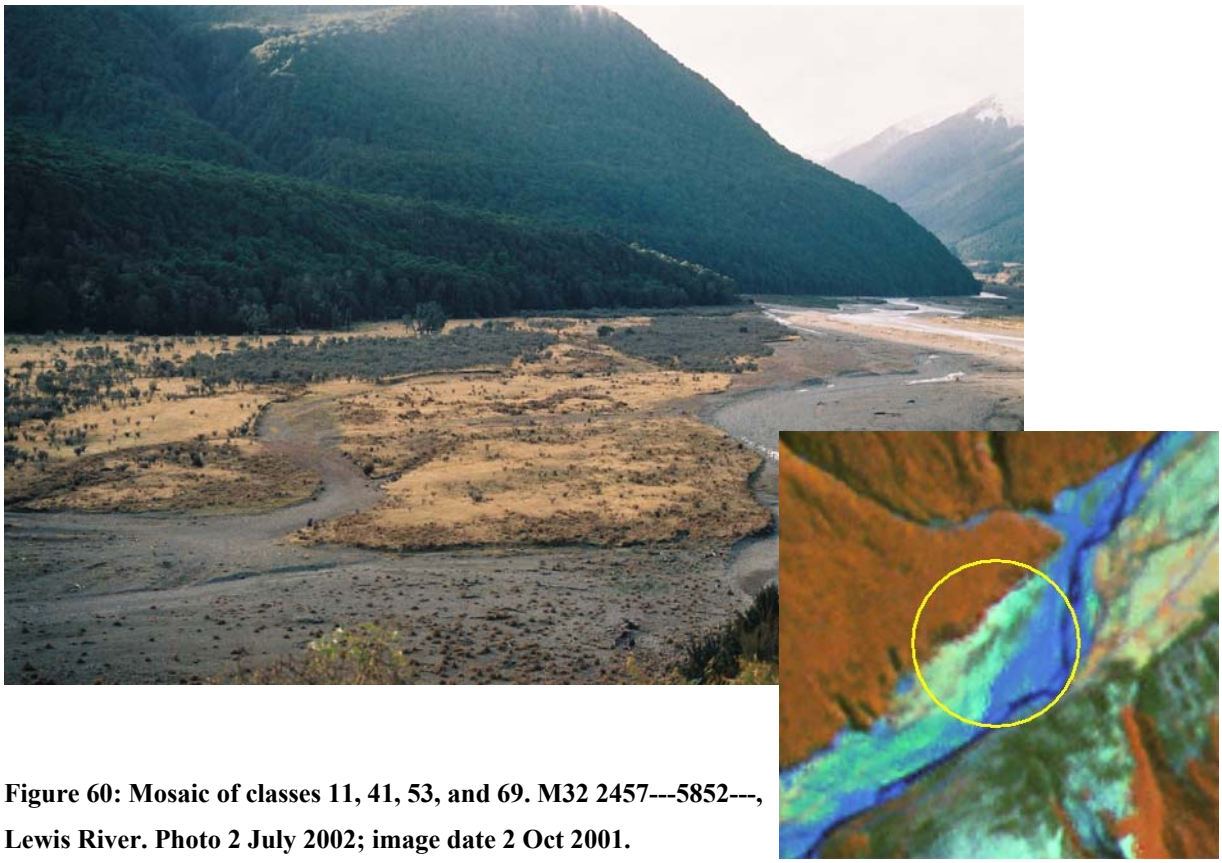


**Figure 60: Mosaic of classes 11, 41, 53, and 69. M32 2457---5852---, Lewis River. Photo 2 July 2002; image date 2 Oct 2001.**

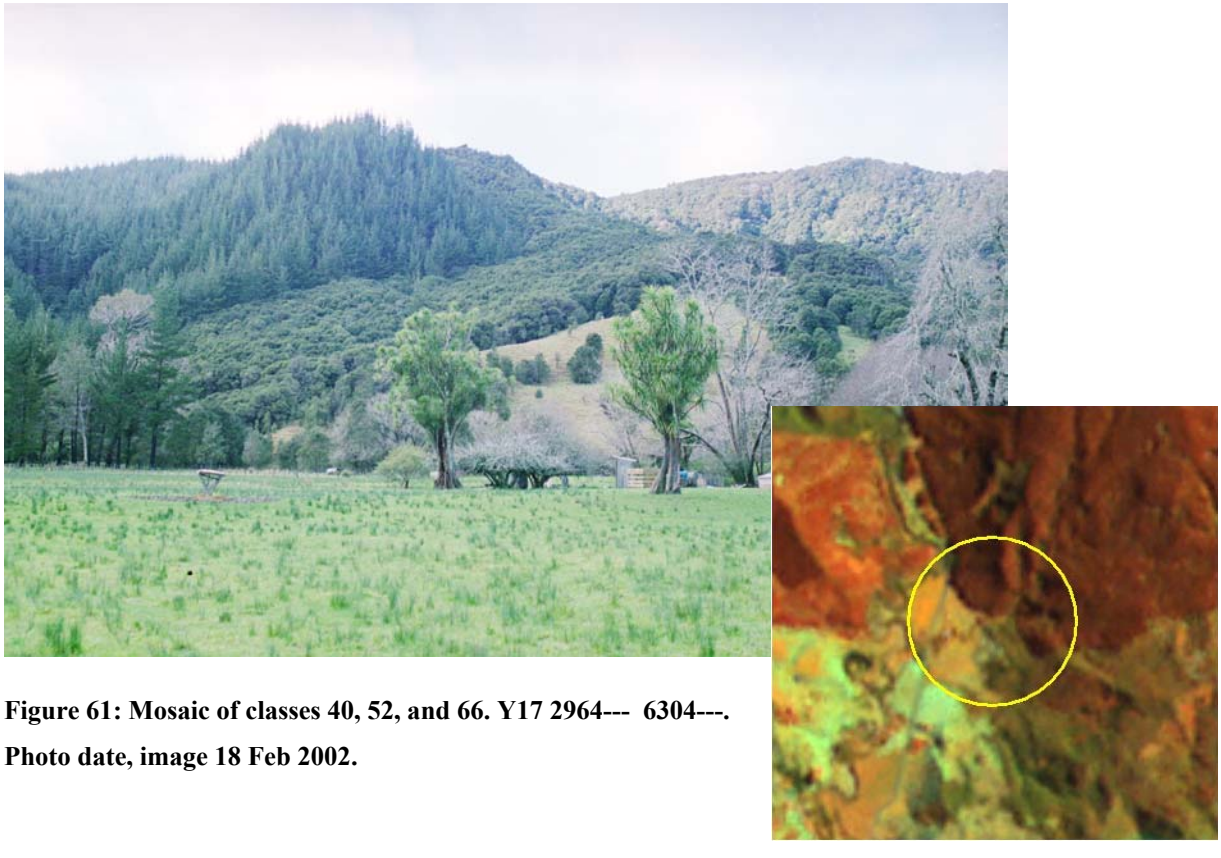


**Figure 61: Mosaic of classes 40, 52, and 66. Y17 2964--- 6304---. Photo date, image 18 Feb 2002.**

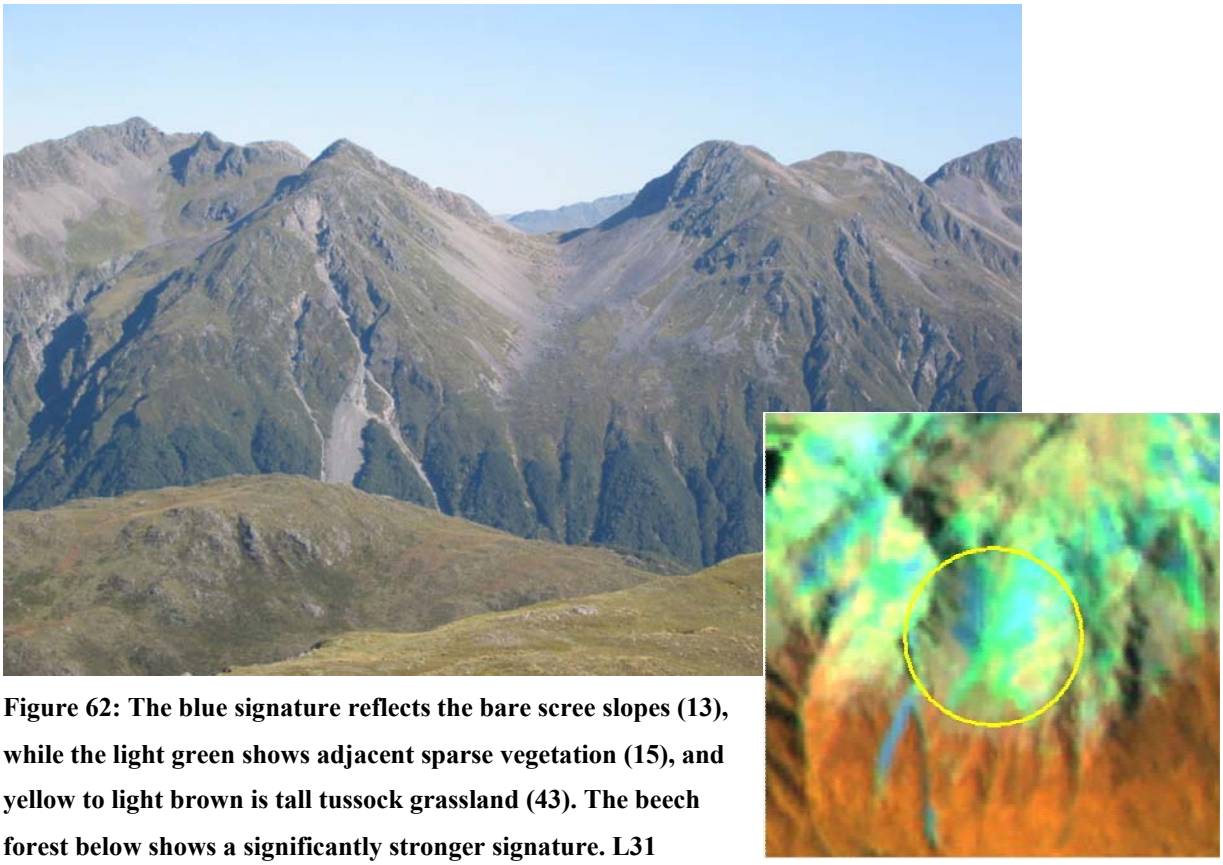


**Figure 62: The blue signature reflects the bare scree slopes (13), while the light green shows adjacent sparse vegetation (15), and yellow to light brown is tall tussock grassland (43). The beech forest below shows a significantly stronger signature. L31 2449065 5861733. Photo 23 March 2003, image date 7 Feb 2002.**

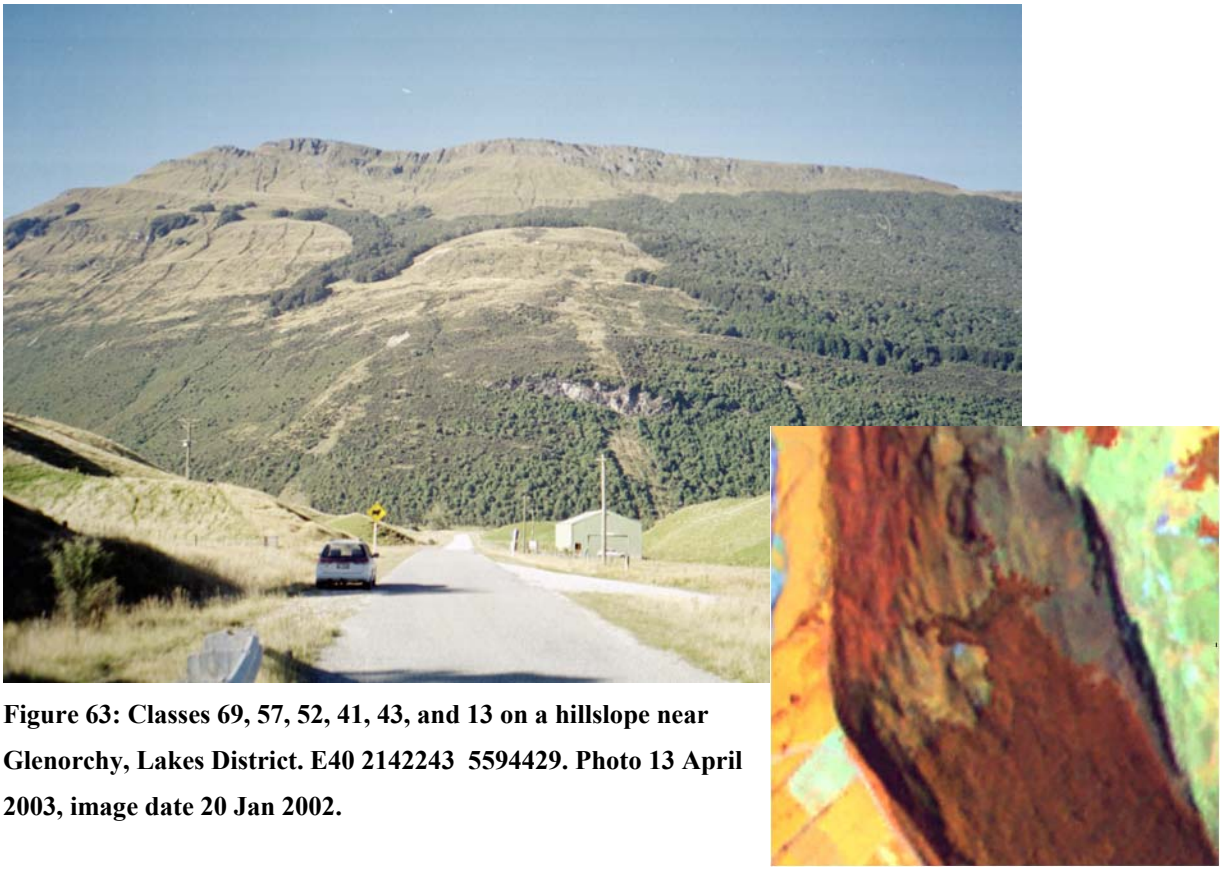


**Figure 63: Classes 69, 57, 52, 41, 43, and 13 on a hillslope near Glenorchy, Lakes District. E40 2142243 5594429. Photo 13 April 2003, image date 20 Jan 2002.**

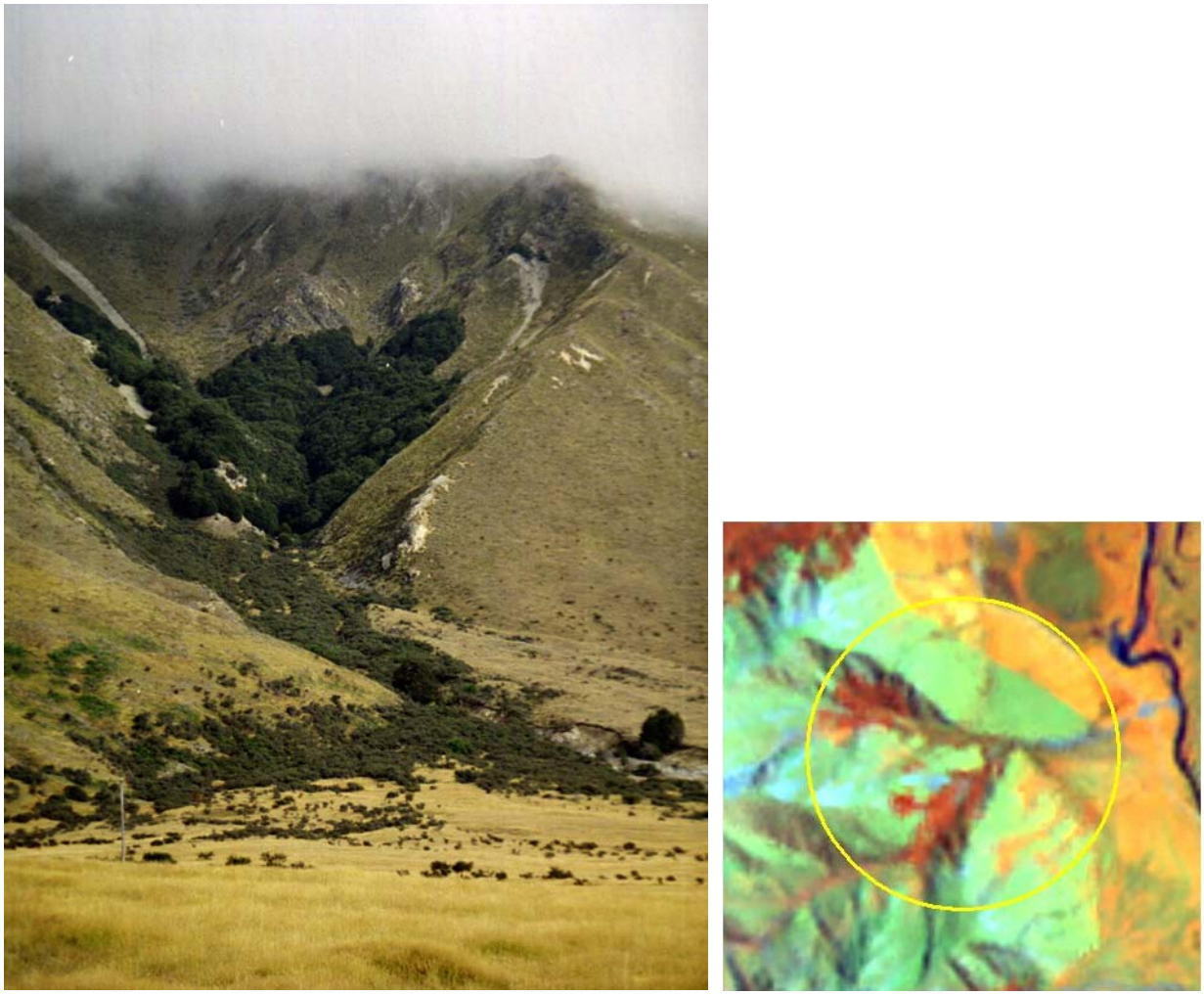


**Figure 64: Classes 69, 57, and 53. Beech forest (69) in the upper gully, grey scrub (57) below, and matagouri (53) on the fan. Grassland is 41 on the lower slopes, replaced by 43 at higher altitudes. Clearly visible also the slips (Class 12) with bare ground. G39 2239369  5647273. Photo 11 March 2003, image date 29 Jan 2001.**

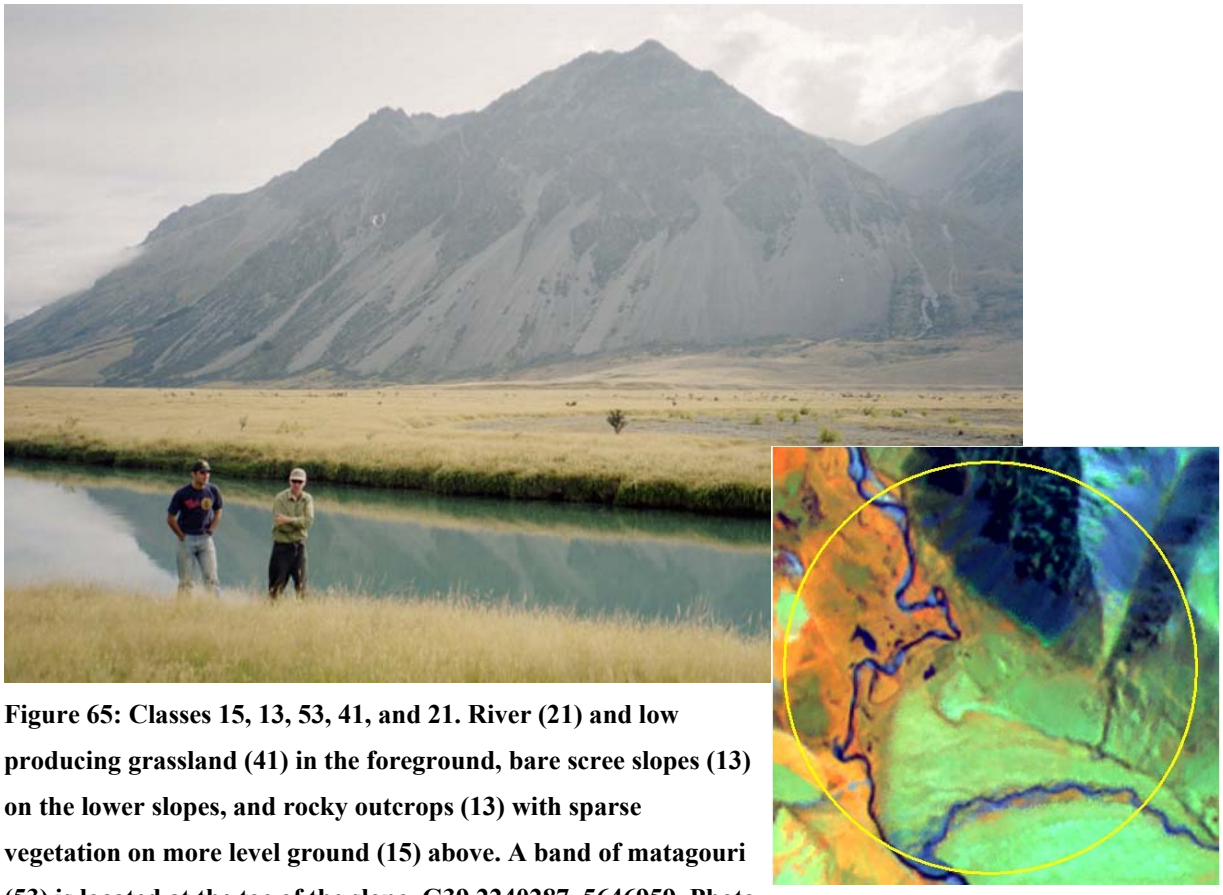


**Figure 65: Classes 15, 13, 53, 41, and 21. River (21) and low producing grassland (41) in the foreground, bare scree slopes (13) on the lower slopes, and rocky outcrops (13) with sparse vegetation on more level ground (15) above. A band of matagouri (53) is located at the toe of the slope. G39 2240287 5646959. Photo 11 March 2003, image date 29 Jan 2001.**

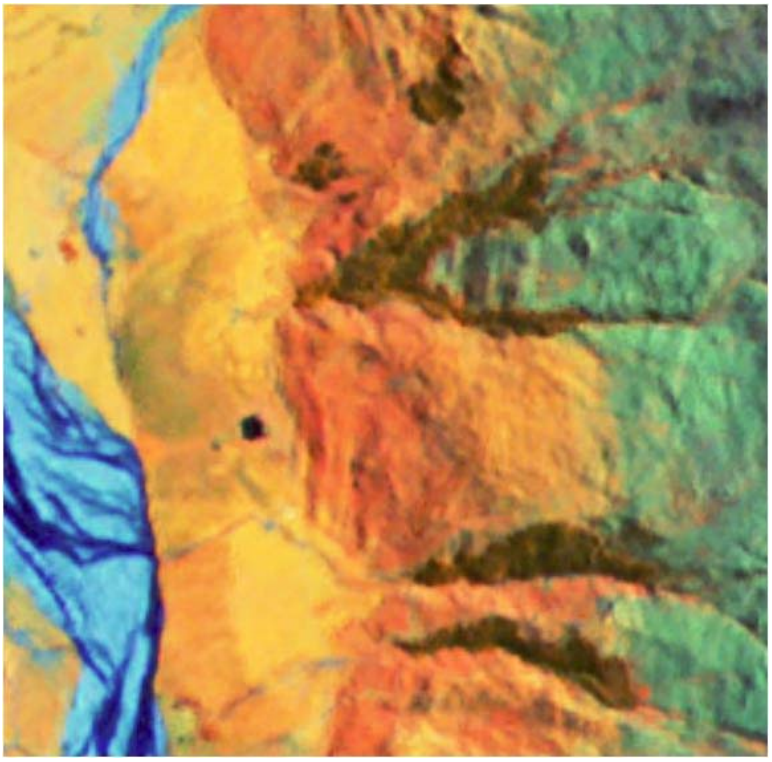


**Figure 66: Typical land cover pattern in farmed valleys of the central South Island: High producing grassland on the river flats grades into less productive grassland on the slopes, often with extensive cover of bracken fern. Tall tussocks characterise the grassland communities only above an altitude of c. 900m. Remnants of forest are present in narrow gullies. F39 2186182  5621605, image date 29 Jan 2002.**

## LAND USE CHANGES

**Figure 141: Land use change, scrub clearance L31 2442074 5872647. Photo 14 March 2003, image date 7 Feb 2002.**

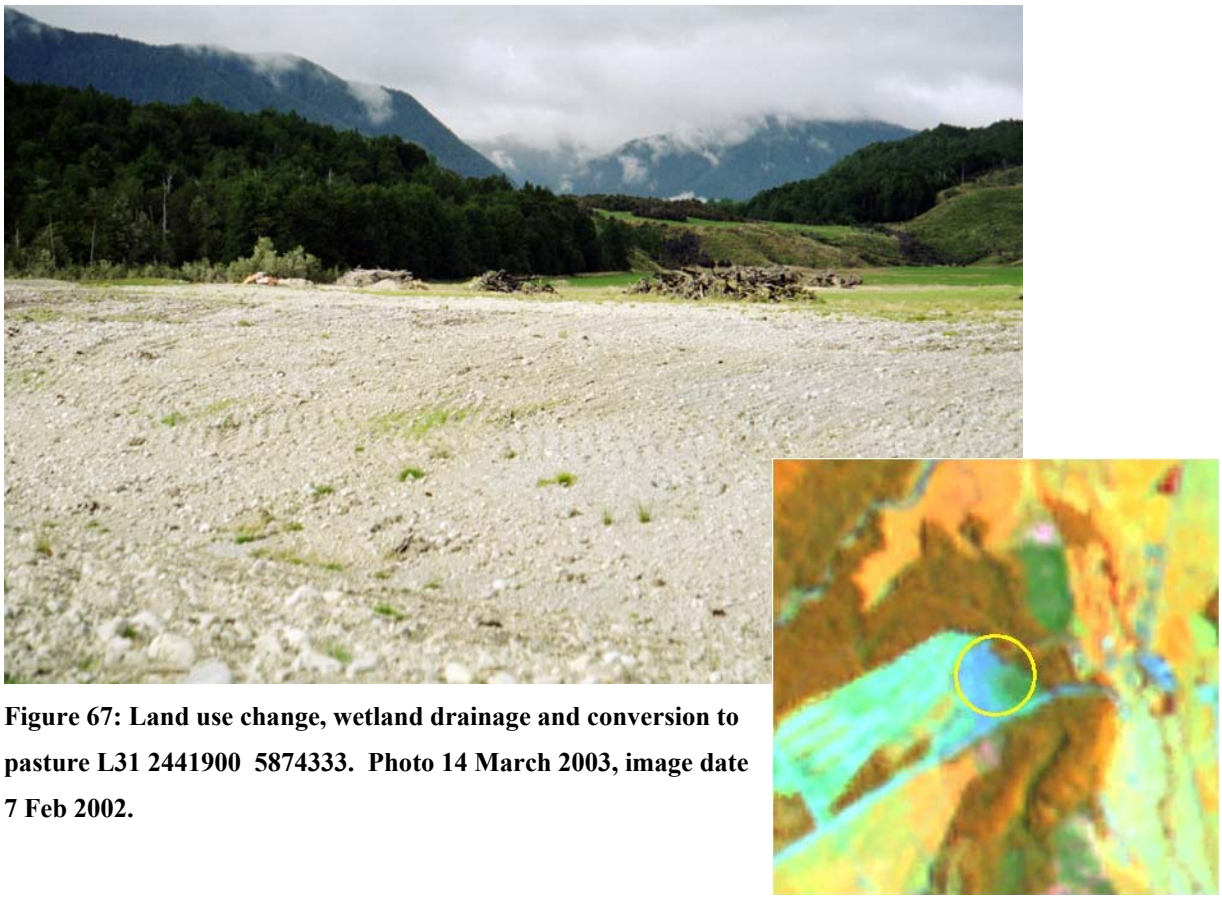


**Figure 67: Land use change, wetland drainage and conversion to pasture L31 2441900 5874333. Photo 14 March 2003, image date 7 Feb 2002.**

## LCDB2 Classes unique to the Chatham Islands

### 55 Peat Shrubland:

Low-growing shrubland community usually dominated by *Dracophyllum spp.* in association with *Cyathodes spp.* and ground ferns. This class is found in extensive areas of the coastal and hill country.

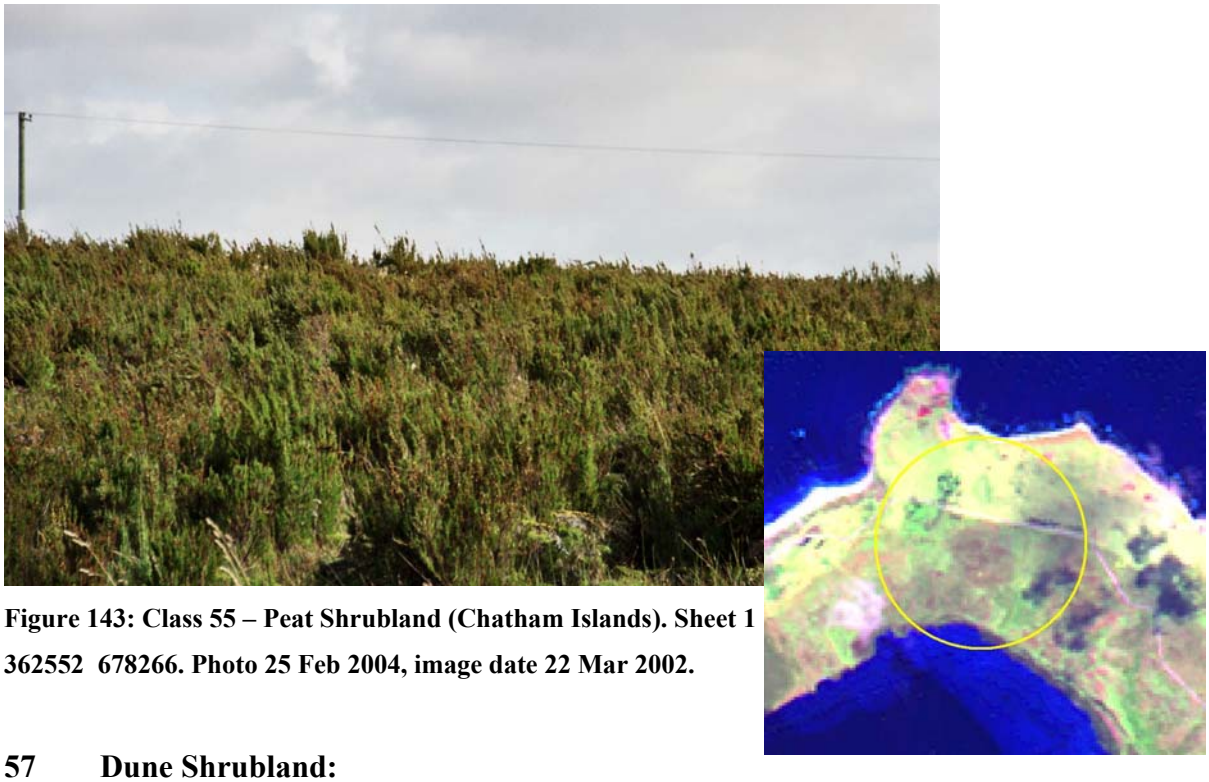


**Figure 143: Class 55 – Peat Shrubland (Chatham Islands). Sheet 1 362552 678266. Photo 25 Feb 2004, image date 22 Mar 2002.**

### 57 Dune Shrubland:

Low-growing shrubland community dominated by *Leucopogon spp.*, *Pimelia arenaria* and *Coprosma spp.*, in association with sedges (*Isolepis spp.*) and scattered herbs and grasses. This vegetation type is found on relatively stable back dunes. It is very common on the dune complexes behind Long Beach and north of Okawa Point.

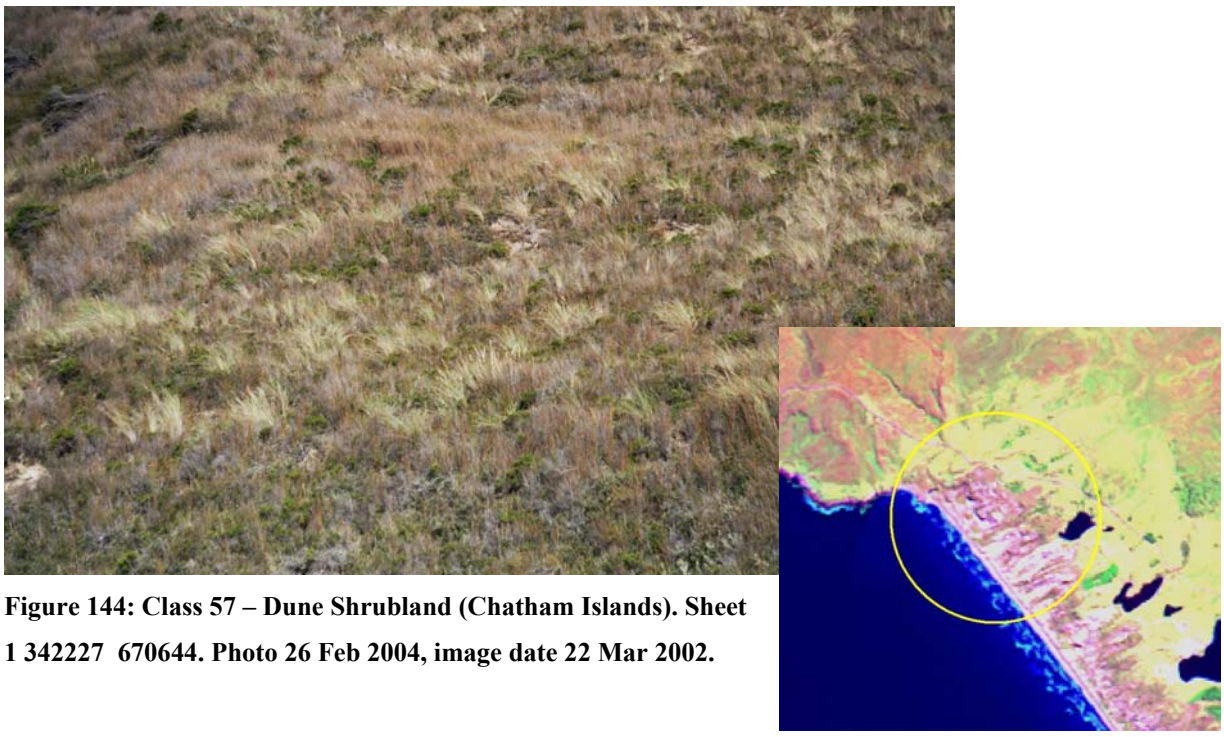


**Figure 144: Class 57 – Dune Shrubland (Chatham Islands). Sheet 1 342227 670644. Photo 26 Feb 2004, image date 22 Mar 2002.**

## 69 Indigenous Forest:

Indigenous Forest on the Chatham Islands is mainly dominated by Chatham Island akeake (*Olearia traversii*), Chatham Island matipo (*Myrsine chathamica*), and karamu (*Coprosma chathamica*). Some stands are dominated by kopi (*Corynocarpus laevigatus*). Tarahinau (*Dracophyllum arboreum*) is prominent in forests of southern Chatham Island and Pitt Island, often in association with other endemic broad-leaved trees. Canopy height is strongly influenced by wind exposure, and ranges from 2m in exposed locations to 10 - 14m with shelter.

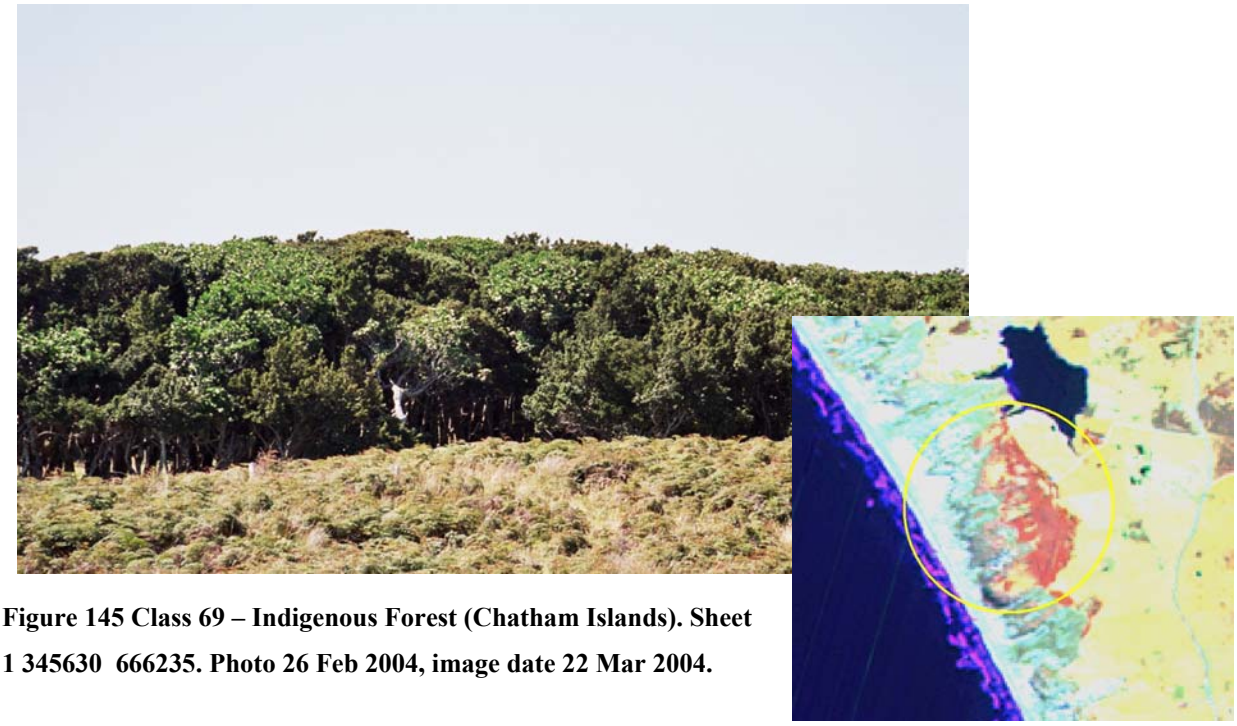
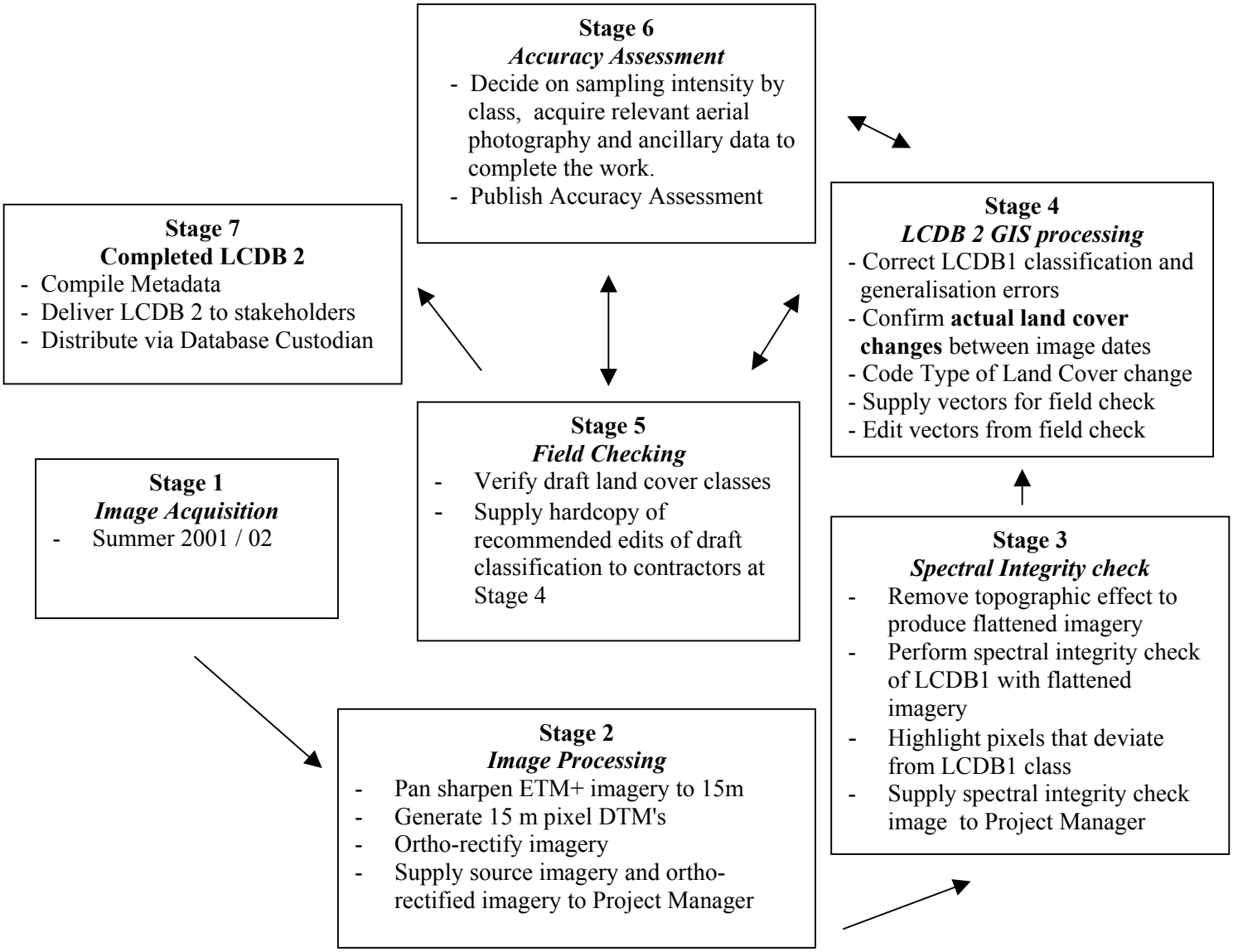


**Figure 145 Class 69 – Indigenous Forest (Chatham Islands). Sheet 1 345630 666235. Photo 26 Feb 2004, image date 22 Mar 2004.**

Attachment 1

**Land Cover Database 2 workflow**




**LCDB2 Production Team**

| | |
|---|---|
| Stage 1 | Landcare Research, Lincoln. |
| Stage 2 | Landcare Research, Palmerston North. |
| Stage 3 | Landcare Research, Palmerston North. |
| Stage 4 | Terralink International Limited, Wellington. |
| Stage 5 | AgriQuality New Zealand, Christchurch and Palmerston North. |
| Stage 6 | Explorer Graphics. |
| Stage 7 | Project Manager, Ministry for the Environment. |

Attachment 2

**Table of Target Classes for LCDB2 New Zealand mainland**

| *Ist Order Class* | *LCDB1 Class* | *LCDB2 Class* | |
|---|---|---|---|
| **Artificial Surfaces** | Urban Area | 1 | Built-up Area |
| | Urban Open Space | 2 | Urban Parkland / Open Space |
| | Mines and Dumps | 3 | Surface Mine |
| | | 4 | Dump |
| | | 5 | Transport Infrastructure |
| **Bare or Lightly Vegetated Surfaces** | Coastal Sand | 10 | Coastal Sand and Gravel |
| | Bare Ground | 11 | River and Lakeshore Gravel and Rock |
| | | 12 | Landslide |
| | | 13 | Alpine Gravel and Rock |
| | | 14 | Permanent Snow and Ice |
| | | 15 | Alpine Grass-/ Herbfield |
| **Water Bodies** | Inland Water | 20 | Lake and Pond |
| | | 21 | River |
| | | 22 | Estuarine Open Water |
| **Cropland** | Primarily Horticulture | 30 | Short-rotation Cropland |
| | | 31 | Vineyard |
| | | 32 | Orchard and Other Perennial Crops |
| **Grassland** | Primarily Pastoral | 40 | High Producing Exotic Grassland |
| | | 41 | Low Producing Grassland |
| | Tussock Grassland | 43 | Tall Tussock Grassland |
| | | 44 | Depleted Grassland |
| | Inland Wetland | 45 | Herbaceous Freshwater Vegetation |
| **Sedgeland Saltmarsh** | Coastal Wetland | 46 | Herbaceous Saline Vegetation |
| | | 47 | Flaxland |
| **Scrub and Shrubland** | Scrub | 50 | Fernland |
| | | 51 | Gorse and or Broom |
| | | 52 | Manuka and or Kanuka |
| | | 53 | Matagouri |
| | | 54 | Broadleaved Indigenous Hardwoods |
| | | 55 | Sub Alpine Shrubland |
| | | 56 | Mixed Exotic Shrubland |
| | | 57 | Grey Scrub |
| **Forest** | | 60 | Minor Shelterbelts |
| | Major Shelterbelts | 61 | Major Shelterbelts |
| | Planted Forest | 62 | Afforestation (not imaged) |
| | | 63 | Afforestation (imaged, post LCDB 1) |
| | | 64 | Forest - Harvested |
| | | 65 | Pine Forest - Open Canopy |
| | | 66 | Pine Forest - Closed Canopy |
| | | 67 | Other Exotic Forest |
| | Willows and Poplars | 68 | Deciduous Hardwoods |
| | Indigenous Forest | 69 | Indigenous Forest |
| | | 70 | Mangrove |

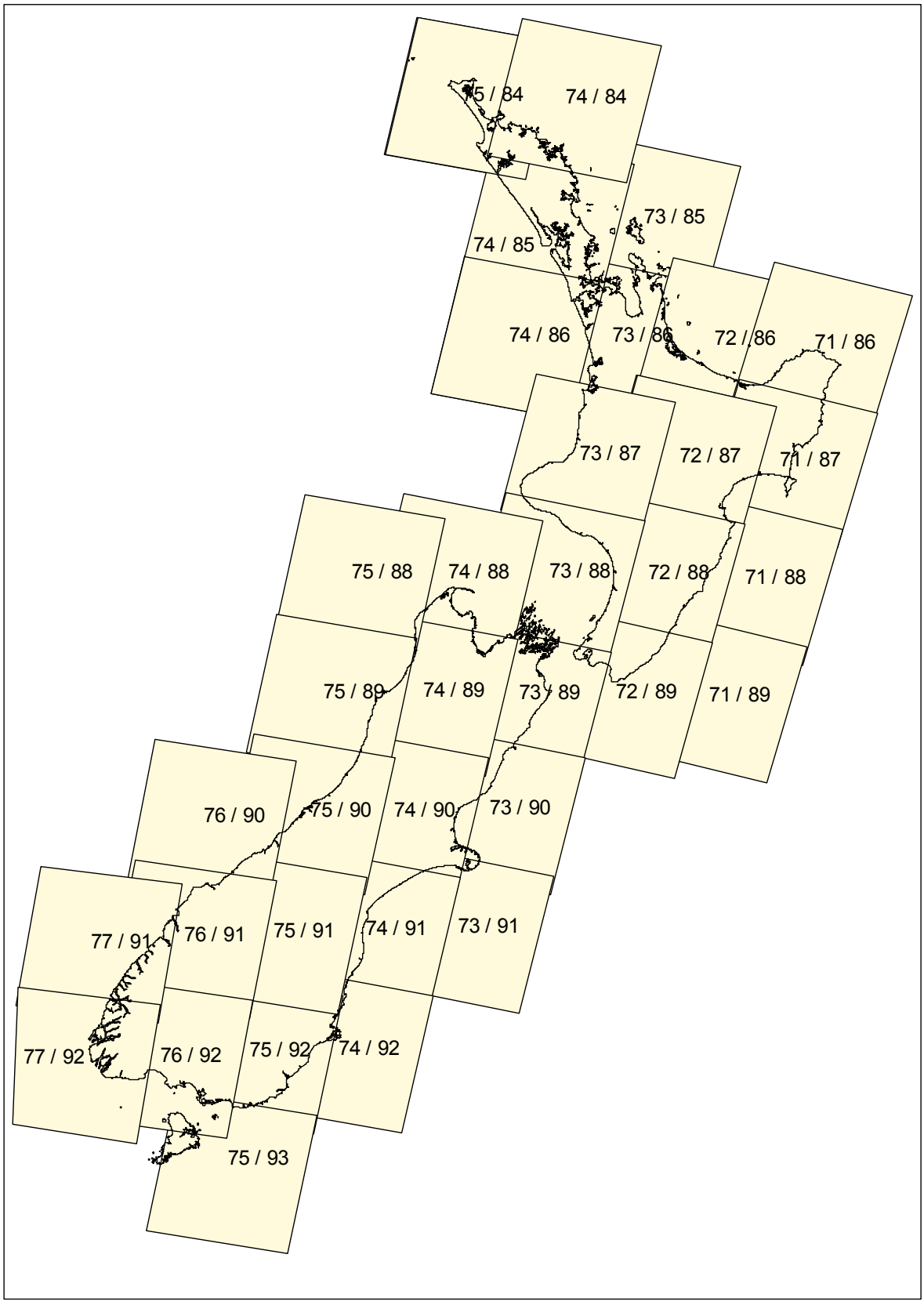
Attachment 3

**Table of Target Classes for LCDB2 Chatham Islands**

| *Ist Order Class* | | | *LCDB2 Class* | |
|---|---|---|---|---|
| **Artificial Surfaces** | | | 1 | Built-up Area |
| | | | 2 | Urban Parkland / Open Space |
| | | | 3 | Surface Mine |
| | | | 4 | Dump |
| **Bare or Lightly Vegetated Surfaces** | | | 10 | Coastal Sand and Gravel |
| | | | 13 | Gravel and Rock |
| | | | 14 | Permanent Snow and Ice |
| | | | 15 | Alpine Grass-/ Herbfield |
| **Water Bodies** | | | 20 | Lake and Pond |
| | | | 21 | River |
| | | | 22 | Estuarine Open Water |
| **Cropland** | | | 30 | Short-rotation Cropland |
| **Grassland** | | | 40 | High Producing Exotic Grassland |
| | | | 41 | Low Producing Grassland |
| **Sedgeland Saltmarsh** | | | 45 | Herbaceous Freshwater Vegetation |
| | | | 46 | Herbaceous Saline Vegetation |
| | | | 47 | Flaxland |
| **Scrub and Shrubland** | | | 50 | Fernland |
| | | | 51 | Gorse and or Broom |
| | | | 54 | Broadleaved Indigenous Hardwoods |
| | | | 55 | Peat Shrubland |
| | | | 56 | Mixed Exotic Shrubland |
| | | | 57 | Dune Shrubland |
| **Forest** | | | 61 | Major Shelterbelts |
| | | | 64 | Forest - Harvested |
| | | | 65 | Pine Forest - Open Canopy |
| | | | 66 | Pine Forest - Closed Canopy |
| | | | 67 | Other Exotic Forest |
| | | | 68 | Deciduous Hardwoods |
| | | | 69 | Indigenous Forest |

Attachment 4

**Extents of Landsat 7 ETM+ images used for LCDB2**



Attachment 5

## Landsat 7 ETM+ images used for LCDB2

| SATELLITE | SENSOR | PATH_ROW | STATION | SCENE_ID | Extent |
|---|---|---|---|---|---|
| Landsat 7 | ETM+ | 71 / 86 | Hobart | 071086_20020117_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 71 / 87 | Hobart | 071087_20020218_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 86 | Hobart | 071086_20020124_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 87 | Hobart | 072087_20020124_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 87 | Hobart | 072087_20020124_ETM+rp.img | Quad |
| Landsat 7 | ETM+ | 72 / 88 | Hobart | 072088_20010902_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 88 | Hobart | 072088_20020918_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 88 | Hobart | 072088_20011105_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 88 | Hobart | 072088_20020225_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 72 / 88 | Hobart | 072088_20021023_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 73 / 85 | Hobart | 073085_20011011_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 73 / 86 | Hobart | 073086_20010925_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 73 / 87 | Hobart | 073087_20010925_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 73 / 87 | Hobart | 073087_20020311_ETM+rp.img | Quad |
| Landsat 7 | ETM+ | 73 / 88 | Hobart | 073088_20011230_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 73 / 89 | Hobart | 073088_20011230_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 73 / 90 | Hobart | 073090_20011230_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 84 | Hobart | 074084_20020327_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 85 | Hobart | 074085_20020122_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 88 | Hobart | 074088_20011103_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 89 | Hobart | 074089_20011002_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 89 | Hobart | 074089_20020207_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 89 | Hobart | 074089_20020214_ETM+rp.img | Quad |
| Landsat 7 | ETM+ | 74 / 90 | Hobart | 074090_20011002_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 91 | Hobart | 074091_20011018_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 74 / 91 | Hobart | 074091_20020311_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 75 / 84 | Hobart | 075084_20020214_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 75 / 84 | Hobart | 075084_20020318_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 75 / 92 | Hobart | 075092_20010129_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 75 / 92 | Hobart | 075092_20011126_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 75 / 92 | Hobart | 075092_20011219_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 76 / 91 | Hobart | 0767091_20020120_ETM+rp.img | Full |
| Landsat 7 | ETM+ | 77 / 91 | Hobart | 077091_20020127_ETM+rp.img | Full |

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**AUTHORS**

Steve Thompson, Project Manager, Ministry for the Environment.
Dr Ingrid Grüner, Project Ecologist, AgriQuality New Zealand Limited.
Nelson Gapare, GIS / Remote Sensing Analyst, AgriQuality New Zealand Limited.