REEF COVER AND ZONATION CLASSIFICATION SYSTEM FOR USE WITH REMOTELY SENSED GREAT BARRIER REEF DATA: USER GUIDE AND HANDBOOK

D. KUCHLER

Great Barrier Reef Marine Park Authority

Technical Memorandum
GBRMPA — TM — 9

GREAT BARRIER REEF MARINE PARK AUTHORITY
TECHNICAL MEMORANDUM GBRMPA-TM-9

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D. A. KUCHLER

March 1987
(submitted 1983)

SUMMARY

The operational use of the Reef Cover and Zonation Classification System for use with Remotely Sensed Great Barrier Reef data, is outlined. A recommended data recording handbook is described for efficient recording from the classification system, whether it be in the laboratory or the field. The handbook is designed to be held in the palm of one hand and to be water resistant when used in the field. It comprises the classification system and data recording cards which are stored in an inside pocket. Each card has facilities for eight sample site recordings.

KEYWORDS: coral reef, classification system, data recording handbook, GBR, remote sensing.

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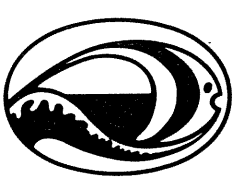
ISSN 0817-6094
ISBN 0-642-52561-7



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EXECUTIVE SUMMARY

Introduction

This memorandum is one of a series of four GBRMPA Technical Memoranda dealing with the terminology, recognition and classification of coral reef cover and zonation features for use with the analysis of remotely sensed data of the Great Barrier Reef.

Objective of the Memorandum

The memorandum outlines how to use the reef cover and zonation classification system designed for use with remotely sensed coral reef data efficiently and easily and easily. It instructs users in the systematic recording of information obtained from field sample and remotely sensed data in the coral reef analysis process. The feature terminology and reef coral and zonation classification system were described in GBRMPA Technical Memoranda 7 and 8 respectively.

A data recording handbook designed for efficient use in the field laboratory is described and worked examples are given.

Summary

The classification system is an attempt to develop a standard for the classification of reef cover and zonation in the Great Barrier Reef region to facilitate comparison and evaluation of interpretations of remotely sensed data. The system is user oriented and based on a logical division approach to classification but is not strictly hierarchical so that classification decisions are not hierarchically dependant. This could limit its usefulness beyond the mapping phase.

The system is based on five primary categories by criteria which are visible on, or inferrable from, remotely sensed data. The chosen criteria are (I) Zones, (II) Features, (III) Composition and/or Position, (IV) Condition and/or Pattern and/or Morphology, (V) Presence. A secondary categorising structure permits the ready classification of mixed data, i.e. when a mapped unit consists of a mixture of surface cover types or features. Multiple entries, to allow for features which can be categorised into more than one primary group, are permitted.

Coding of features is generally numeric to facilitate transfer of the recorded data between interpreter, recorder, operator and computer files.

Conclusion

The data recording book described provides a useful basis for development as a standard issue for use by field observers and air photo and image interpreters. Further discussion with other researchers and end users of the resultant data is required before the schema could be recommended and/or adopted as a universal data recording standard for the region. The system is simple enough in concept but the number of possible entries required for some features would be cumbersome until the user was thoroughly familiar with the given range. This is however a criticism common of most in-the-field recording systems.

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1. INTRODUCTION

In recent years, the Great Barrier Reef (GBR) has been mapped by many workers. Maps have been produced at scales which depict individual reefs (Stoddart, 1969, 1978; Flood, 1977); reef regions (Stoddart et al., 1978); and the whole Great Barrier Reef province (Maxwell, 1968; GBRMPA, 1983). During recent mapping projects (Jupp et al., 1985; Kuchler, 1984) it became evident that these maps were not compatible because the labels used to represent reefal cover and zonal units were not standard. For this reason, the information could not be easily integrated into a GBR data base.

Since a standardised labelling procedure is required for mapping geomorphological features in GBR remote sensing projects and for GBR mapping in general, a method was devised. The method has three components: a standardised geomorphological nomenclature of the GBR; a classification system which categorises and attributes labels to the nomenclature; and, a classified data recording system. Each component has been presented in a separate GBRMPA Technical Memorandum.

In one paper (Kuchler, 1986b), a nomenclature for geomorphological features on reefs within the GBR is presented. There is presently insufficient ground data by which to verify terms, so the nomenclature adopts the most frequently used terms in the literature.

The other paper (Kuchler, 1986a) categorises the nomenclature, attributes labels, and forms it into a classification system for use in the mapping process. The classification system was designed for labelling reef covers on maps, for labelling interpreted reef covers on aerial and orbital remotely sensed GBR images, and for recording ground data. Since the classification system has already been presented, this third paper describes and illustrates the classified data recording method. A handbook and data recording card format which facilitate easy recording are presented in the appendices of this paper.

2. CLASSIFICATION SYSTEM DESIGN

The rationale behind, and the design of the classification system are described in Kuchler (1986b). To make this presentation more meaningful, a brief reiteration is given here.

The classification system was devised for the following two reasons;

- to provide a standard for classifying and labelling geomorphological information on reef covers and zonation. Such information may be derived from remotely sensed data or from field observations,

- to provide a standard which allows the comparison and evaluation of interpretations of different types of remotely sensed data.

The system is built on information needed by the potential user and is based on the logical division approach to classification (Ryerson and Gierman, 1975). It has both primary and secondary categorising structures.

2.1 Primary categorising structure

The classification system has five levels which form the primary categorising structure. Each level attempts to categorise reef features according to different criteria which are important to mapping of the GBR using remotely sensed data. Thus, the classificatory form and purpose are inextricably bound together. The criteria chosen for each level are as follows:

Level I : Zones
Level II : Features
Level III : Composition and/or position
Level IV : Condition and/or pattern and/or morphology
Level V : Presence

Table 1. Full listing of data categories as used in this classification system.

LI: ZONES	LII: FEATURES	LIII: COMPOSITION POSITION	LIV: CONDITION, PN, MORPHOLOGY	LV: PRESENCE
5 Ocean	5 Slope	5 Upper	5 Steep	5 0-10%
6 Off rf floor	6 Moat	6 Middle	6 Gentle	6 10-20%
7 Rf shoal	7 Smarine moat	7 Lower	7 Live state	7 20-30%
8 Rf flank	8 Patch rf	8 North	8 Dead state	8 30-40%
9 Mtple reef front	9 Coral Head	9 South	9 Mixed state	9 40-50%
10 Spur groove	10 Coral pool	10 East	10 Aligned Pn	10 50-60%
11 Rf slope	11 Microatoll	11 West	11 Truncated Pn	11 60-70%
12 Rf rock slope	12 Pool	12 Windward	12 Patched Pn	12 70-80%
13 Back rf z	13 Rock	13 Leeward	13 Reticulate Pn	13 80-90%
14 Patch rf z	14 Ridge	14 Phosphate	14 Dispersed Pn	14 90-100%
15 Rf rim	15 Rim	15 Reef	15 Remnant Pn	15 <.5m
16 Rf flat	16 Rampart	16 Rampart	16 Deltaic Pn	16 .5-1m
17 Rf top	17 Bassett edge	17 Beach	17 Sheet Pn	17 1-2m
18 Rf flat	18 Bank	18 Boulder	18 Circular	18 2-3m
19 Outer rf flat	19 Tongue	19 Algal coating	19 Oval	19 3-4m
20 Inner rf flat	20 Platform	20 Algae macro	20 Continuous	20 4-5m
21 Living coral z	21 Boulder tract	21 Algal encrust	21 Intermittant	21 5-6m
22 Dead coral z	22 Wedge	22 Seagrass	22 Isolated	22 6-8m
23 Aligned coral z	23 Terrace	23 Coral	23 Turbid state	23 8-10m
24 Rubble z	24 Shoal	24 Rubble	24 Moderate state	24 10-15m
25 Sand z	25 Chute	25 Shingle	25 Calm state	25 15-30m
26 Seagrass z	26 Sand patch	26 Sand	26 Coarse grained	26 30-35m
27 Lagoon	27 Rf rim lagoon	27 Sediment	27 Med grained	27 >30m
28 Shal lagoon	28 Lagoon wall	28 Conglomerate	28 Fine grained	28 Var depth
29 Med lagoon	29 Lagoon floor	29 Living margin	29 Supra tidal	29 Lgt cover
30 Deep lagoon	30 Beach	30 Dead surface	30 Inter tidal	30 Med cover
31 Blue hole	31 Dune	31 Breaking waves	31 Sub tidal	31 Hvy cover
32 Cay	32 Spit	32 Part vegetated	32 Single level	
33 Island	33 Spur	33 Clear vegetatn	33 Mtple level	
34 Cloud	34 Groove	34 Dune vegetatn	34 Enclosed	
35 Shadow	35 Perimeter	35 Mangrove	35 Part open	
	36 Vegetated	36 Mangrove swamp	36 Fully open	
FOR ALL LEVELS	37 Unvegetated	37 Ponded water	37 Narrow gutter	**FOR ALL LEVELS**
X Data anomaly	38 Chnl btwn rf	38 Boat	38 Shal wide dep	X Data anomaly
? Field data req	39 Chnl rf top	39 Wharf	39 Perm feature	? Field data req
N Level not used	40 Chnl deltaic Pn	40 Building	40 Temp feature	N Level not used
		41 Walking track		
		42 Engin Constr		
		43 Wreckage		

The categorising criteria are not strictly hierarchical, so decisions are not hierarchically dependent when classifying a mapped unit into more than one level.

2.2 Secondary categorising structure

The classification system was designed with a secondary categorising structure to allow for the classification of mixed data. Mixed data occur when a mapping unit is composed of a mixture of surface covers and/or zones. Consequently, it may classify into more than one category within any level in the classification system. Mixed areas are a significant feature of the reef surface when it is viewed from the resolution of a Landsat MSS image (1 pixel = 0.5 hectare).

One example of mixed data is the mixed pixels or 'mixels' which occur in satellite imagery because of a less than optimum relationship between the recording system resolution and target size. Another example is ground sample sites which, when determined by statistical random sampling methods, often occur on the boundaries between different reef covers or zones (Kuchler, 1984). Hallum (1972) states that, from space altitudes, many of the ground resolution elements are individually composed of a mixture of object categories and many of the data points generated by multispectral sensors are not characteristic of any single object category. Thus, the purpose of the secondary categorising structure is to allow for more than one category to be recorded for any level within the classification system. For example, a sample site on the ground corresponding to a 'mixel' on the Landsat image may be composed of both a living and a dead coral zone, so category numbers 21 and 22 of Level I would be recorded.

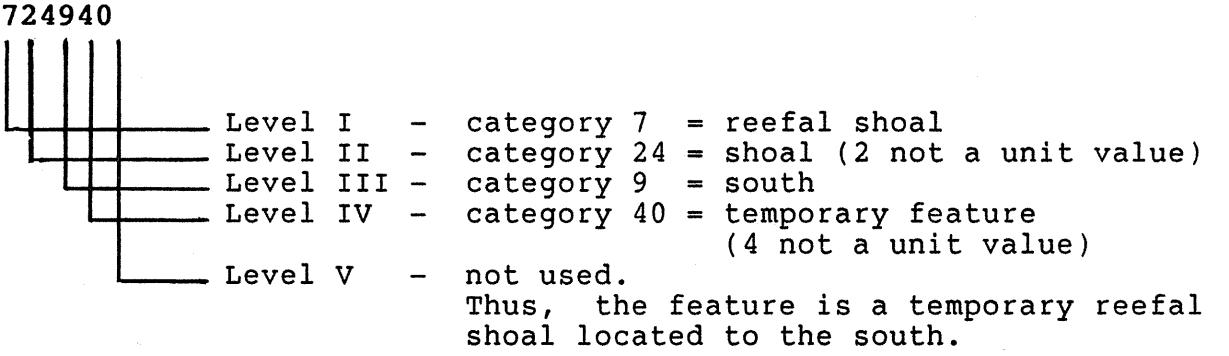
2.3 Multiple entries

The classification system also has multiple entries since some features categorise into more than one of the five levels. The term 'beach' for example, is a category of both Levels II and III. This is because 'beach' is both a reef feature (Level II) and the composition of a feature (Level III), as in the term 'beach ridge' where 'ridge' is the feature and 'beach' is the composition.

2.4 Coding symbols

The numerals 5 to 49 were chosen as the classification coding symbols for the following two reasons:

- They support a five column matrix from which original unclassified information can be systematically retrieved. Numerals 1 to 4 have not been used, and therefore are not unit value coding symbols. These numerals have been reserved for the retrieval process where they indicate that the coding symbol in the recording is a value in tens rather than a unit value. For example, the entry **724940** is retrieved as:



Numerals greater than 49 cannot be used for coding symbols because they are prefixed by numbers which are used as unit value coding symbols. The number of categories available for classification at each level is therefore limited to forty-nine.

- In transferring data between interpreter and interpreter; interpreter and recorder; and operator and computer files; a shorter, simpler and more accurate communication exists with numerals, rather than with upper and lower case alphabetic letters.

3. DATA RECORDING HANDBOOK

The data recording handbook is necessary for efficient recording from the classification system both in the laboratory and in the field. The handbook is designed to be held in the palm of one hand and to be water resistant in the field. It comprises the classification system and data recording cards. In the classification system, some entries have been abbreviated (Table 2) to allow the listing to fit within the dimensions of the handbook. The recording cards are stored in an inside pocket of the handbook (Figure 1). Each card has facility to record eight sample site recordings (Figure 2).

Figure 1. Example of the field handbook which contains the data recording cards.
The listing of data categories is that which appears in Table 1.

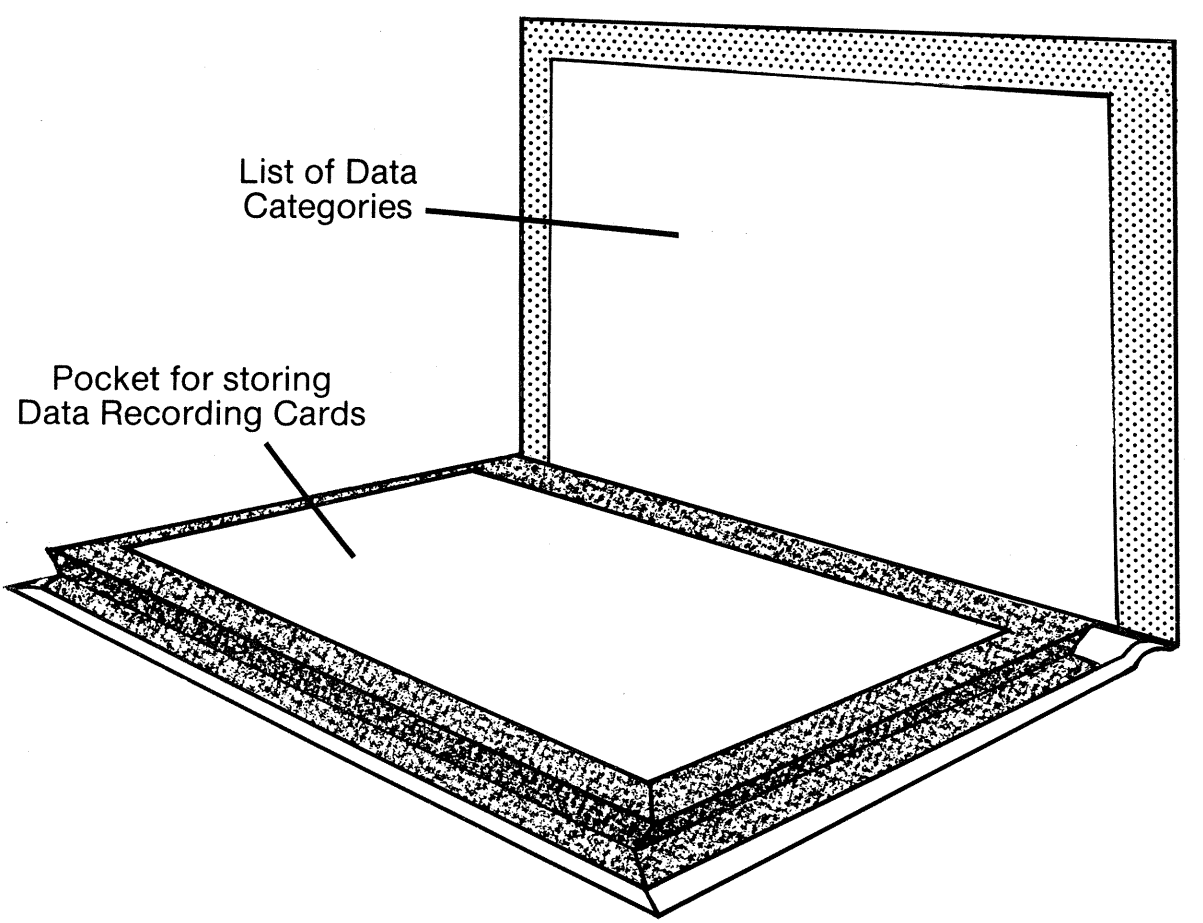


Table 2. Abbreviated entries for the classification system.

Abbreviated entry name	Complete entry name
L	Level
Mtple	Multiple
Spur Groove	Spur and Groove
Rf	Reef
Z	Zone
Shal	Shallow
Med	Medium
Req	Required
Smarine	Submarine
Chnl	Channel
Btwn	Between
Pn	Pattern
PN	Pattern in Level IV title
Encrust	Encrusting
Part	Partially
Clear	Cleared
Vegetatn	Vegetation
Engin	Engineering
Constr	Construction
Mixed	Mixed live and dead
Sgle	Single
Dep	Depression
Perm	Permanent
Temp	Temporary
.5	0.5 m water
Var Depth	Variable water depth
Lgt	Light
Cover	Covering
Hvy	Heavy

4. USE OF CLASSIFICATION SYSTEM

Two sequential procedures are involved in using the classification system: categorisation of the data; and, recording of the categorisation. Use of the primary and/or secondary classification structures is controlled by the decision making process, data scale, and classification purpose.

4.1 The decision making process

The interpretation of remotely sensed imagery or of ground covers at a reef site involves the following four steps;

- detection of features,
- recognition and identification of features,
- analysis and delineation of patterns,
- and classification.

A decision regarding the detectability of a feature is made in step one. Decisions regarding the precise identification and delineation of a feature are made in steps two and three. These two are the principal decision-making steps, and involve a combination of nomenclature decisions and general classification concepts. The first three steps are iterative until a final nomenclature decision is reached. A feature is named using the nomenclature presented in Kuchler (1986a). In the final step, the decision is categorised and labelled according to the classification system and then recorded.

4.2 Recording classified data

A critical component in using the classification system is the method of recording. The method, specifically outlined later, ensures that:

- the original pre-classification information can be retrieved

- the recording is efficient and compact, even though it may be lengthy at times

The method is systematic and consistent, and is built on the following five rules:

- The recording follows a matrix array in which 5 x 49 entries are the maximum. The 5 columns represent the five classification levels, and 49 rows represent the maximum number of multiple selections possible within any particular level.

- Each classification level occupies a unique and sequential place in a five column matrix array:

  Level I occupies column 1, the first position in any row in the matrix.

  Level II occupies column 2 and the second position.

  Level III occupies column 3 and the third position.

  Level IV occupies column 4 and the fourth position.

  Level V occupies column 5 and the fifth position.

- All multiple coding selections from any level are recorded in their respective column positions in any row in the matrix.

- With the obvious exception of Level I, the recording for any level must be preceded by a recording for each previous level. For example, a Level II record is preceded by a Level I record; and a Level IV record is preceded by records in columns 1 to 3 (Levels I, II, III). Such a system allows the classification levels to which the labels refer to be sequentially deduced from a matrix array.

- Since Levels I and II classify data at broader scales, an efficient and compact recording results, if all the categories in Levels I and II are considered before selecting categories from other levels.

For example, an 'aligned coral zone' would be inefficiently classified and bulkily recorded in the following classification:

LEVEL I	LEVEL II	LEVEL III	LEVEL IV
19-Outer Rf Flat	N-Level not used	23-Coral	10-Aligned Pn

which in the recording system is represented as **19N2310.**

A more efficient and compact recording would be;

Level I
19-Outer Rf Flat
23-Aligned coral Z

which, in the recording system is represented as **19**
23

4.3 Use of primary categorising structure

Use of the primary categorising structure follows the rules outlined earlier and is detailed here. Classifying data into the primary structure involves selecting <u>one</u> category from one or more of the five levels. The category labels are recorded from left to right and sequentially for each level. Thus, the first row of the matrix is formed. A series of examples illustrate its use.

<u>Use of a single level</u>

<u>Example 4.1</u> Use of Level I only: category 26 - Seagrass zone
record as **26**

<u>Example 4.2</u> Use of Level II only: category 5 - Slope
record as **N5**
(N = Level I unused)

<u>Example 4.3</u> Use of Level III only: category 37 - Ponded water
record as **NN37**
(NN = Levels I and II unused)

Use of multiple levels

Example 4.4 The use of five levels to classify a seagrass zone heavily covered by live seagrass.

Level I:	category 26 - Seagrass zone record as **26**
Level II:	category N - level unused record as **26N**
Level III:	category 22 - Seagrass record as **26N22**
Level IV:	category 7 - live state record as **26N227**
Level V:	category 31 - heavy cover record as **26N22731**

Retrieval of original information from classified data record

Using the record **26N22731** from the preceeding example.

Always retrieve from left to right, from first to last row, and one row at a time.

The first numeral is 2. Since 2 is not a unit value but a tens value in the labelling system, the numeric value for column one is 26. Column one is used for Level I in which 26 represents Seagrass zone.

In the second column (Level II), the character N indicates no category was recorded.

For the third column (Level III), the first numeral 2 is not a unit value in the labelling system. Therefore, the category number is 22, which in Level III indicates Seagrass.

The first numeral in column four is 7, which is a numeric label in the system. Category 7 in Level IV indicates a Live state.

Three is the first numeral in column five. Since 3 is a tens value in the labelling system, the category is 31. In Level V, 31 indicates a Heavy cover.

Thus the classified information is a seagrass zone heavily covered by live seagrass.

4.4 Use of secondary categorising structure

Use of the secondary categorising structure is conceptually the same as for the primary structure, except the multiple categories can be recorded for each classification level. When the secondary structure is used for one level only, the labels of the multiple categories are simply listed vertically as in the following examples:

Use of a single level

Example 4.5 A site on the top of the outer reef flat which exhibits living coral may be coded, using only Level I categories, as:

17-Reef top
19-Outer reef flat
21-Living coral zone

and recorded as: **17**
19
21

Example 4.6 A site displaying no Level I attributes, but which may be classified into several Level II categories; in this case, an unvegetated sloping beach; could be coded as:

5-Slope
30-Beach
37-Unvegetated

and recorded as: **N5**
N30
N37
(**N** indicating that Level I was unused)

Use of multiple levels

When the secondary structure is used for more than one level in the classification system, its method of use can be conceptualised as a series of layered primary structures which form additional rows in the recording matrix array. The following rules apply:

- Always begin to classify and record from left to right, from Level I to V.

- Always complete the primary classification structure for a category before recording another from the secondary structure.

- For Levels I to IV, always record one category from the secondary classification structure at a time.

- For Level V, record as many categories as is necessary from the secondary structure at a time.

- When more than one Level V category is recorded, complete the primary classification structure for each category, by repeating the Level I to IV entries.

- The primary structure relating to the Level V categories must be complete before another category from Levels I to IV is recorded.

In operation, the following sequence occurs:

Step 1. Make one recording from Level I.
Step 2. Complete the primary classification by recording one category from Levels II, III and IV.
Step 3. Make one or more recordings for Level V.
Step 4. If more than one category is recorded for Level V, repeat the Level I to IV recordings for each category.
Step 5. Reiterate Steps 1 to 4 until all multiple selections for each level have been recorded.

The following examples will illustrate its use:

Use of multiple levels

Example 4.7

Description of sample site:
Seagrass zone - 80% live seagrass
- patch of 20% medium grain sand
- ponded water 0.25 m deep

Classify as:

LEVEL I	LEVEL II	LEVEL III	LEVEL IV	LEVEL V
26-Seagrass zone		22-Seagrass	7-live state	12-80%
26-Seagrass zone	26-Sand patch	26-Sand	27-medium grain	7-20%
26-Seagrass zone		37-Ponded water		15-<0.5m

Record as: **26N22712**
262626277
26N37N15

Example 4.8

Description of sample site:
Seagrass zone - 80% live seagrass
- 20% sand

Classify as:

LEVEL I	LEVEL II	LEVEL III	LEVEL IV	LEVEL V
26-Seagrass zone		22-Seagrass	7-Live state	12-80%
26-Seagrass zone		26-Sand		7-20%

Record as: **26N22712**
26N26N7

Example 4.9

Description of sample site:
Seagrass zone - 100% seagrass covered by 0.25 m water

Classify as:

LEVEL I	LEVEL II	LEVEL III	LEVEL IV	LEVEL V
26-Seagrass zone		22-Seagrass		14-100%
				15-<0.5 m

Record as: **26N22N14**
26N22N15

To retrieve original information from the classified data record, always retrieve left to right, from first to last row, and one row at a time.

Row 1

Column 1 = Level I
Category 26 = Seagrass zone
(2 is not a unit value)
Column 2 = Level II
Category N = Level unused
Column 3 = Level III
Category 22 = Seagrass
Column 4 = Level IV
Category N = Level unused
Column 5 = Level V
Category 14 = 100% cover

Row 2

Columns 1 to 4 (Levels I to IV) same as Row 1
Column 5 = Level V
Category 15 = <0.5 m

Example 4.10

Description of sample site:

Reef rim - Rubble bank with algal encrustation
- Coral head with no living coral

Outer reef flat - Shingle 50%
- Sand 50%
- Windward

Classify as:

LEVEL I	LEVEL II	LEVEL III	LEVEL IV	LEVEL V
15-Reef rim	18-Bank	24-Rubble		
15-Reef rim		21-Algal encrust		
15-Reef rim	9-Coral head	8-Dead state		
19-Outer rf flat		25-Shingle		9-50%
19-Outer rf flat		26-Sand		9-50%
19-Outer rf flat		12-Windward		

Record as:

151824NN	or shortened to	**151824**
15N21NN		**15N21**
1598NN		**1598**
19N25N9		**19N25N9**
19N26N9		**19N26N9**
19N12NN		**19N12**

To retrieve original information from this classified data record, retrieve left to right, from first to last row, and one row at a time.

Row 1

Column 1 = Level I
Category 15 = Reef rim
(1 is not a unit value)

Column 2 = Level II
Category 18 = Bank
(1 is not a unit value)

Column 3 = Level III
Category 24 = Rubble
(2 is not a unit value)

Row 2

Column 1 = Level I
Category 15 = Reef rim
(1 is not a unit value)

Column 2 = Level II
Category N = Level unused

Column 3 = Level III
Category 21 = Algal Encrust
(2 is not a unit value)

Row 3

Column 1 = Level I
Category 15 = Reef rim
(1 is not a unit value)

Column 2 = Level II
Category 9 = Coral head

Column 3 = Level III
Category 8 = dead state

Row 4

Column 1 = Level I
Category 19 = Outer rf flat
(1 is not a unit value)

Column 2 = Level II
Category N = Level unused

Column 3 = Level III
Category 25 = Shingle
(2 is not a unit value)

Column 4 = Level IV
Category N = Level unused

Column 5 = Level V
Category 9 = 40 - 50%

Row 5

Column 1 = Level I
Category 19 = Outer rf flat
(1 is not a unit value)

Column 2 = Level II
Category N = Level unused

Column 3 = Level III
Category 26 = Sand
(2 is not a unit value)

Column 4 = Level IV
Category N = Level unused

Column 5 = Level V
Category 9 = 40 - 50%

Row 6

Column 1 = Level I
Category 19 = Outer rf flat
(1 is not a unit value)

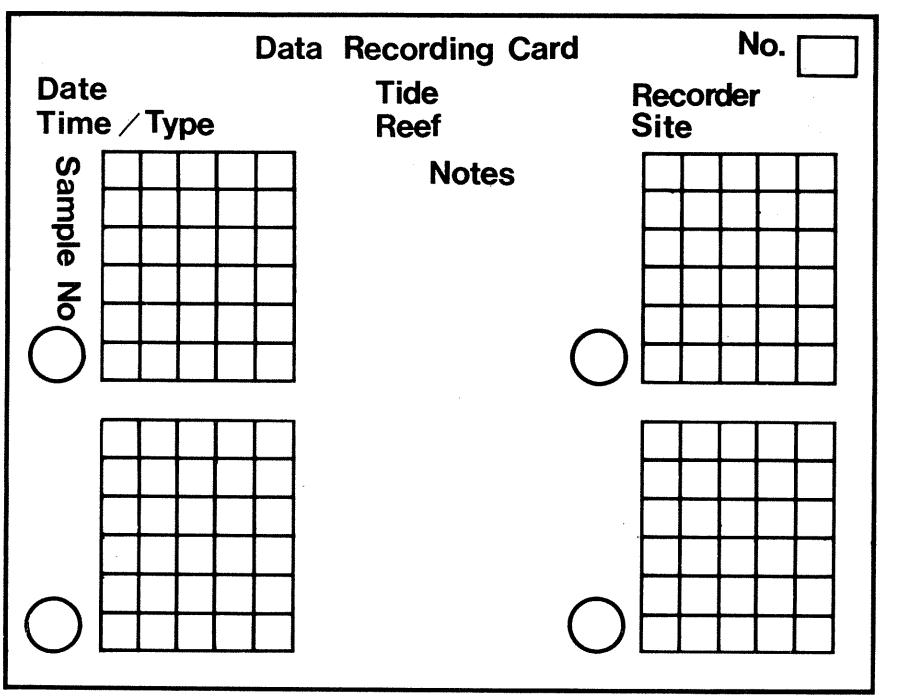
Column 2 = Level II
Category N = Level unused

Column 3 = Level III
Category 12 = Windward
(1 is not a unit value)

5. USE OF CLASSIFICATION SYSTEM WITH RECORDING CARD

Use of the classification system with a recording card is illustrated in the following two examples. Example 4.5 illustrates the simplest of classifications, whilst example 4.10 shows the most complex. In the examples above, and example 5.2 from this section, information on both proportional reef covers and water depth is classified - the secondary structure of Level V is prominent.

Figure 2. Example of the data recording card.
Four samples for each site are able to be recorded on each side of the card. The reverse of the card may have the site data deleted.



Example 5.1 The classification of features in Figure 3:

detect the features for classification

identify features for classification

analyse and delineate features

fill in applicable identifiers at top of recording card:

DRC No	:	1
Date	:	1.8.83
Reef	:	Cairns
Time/type	:	LANDSAT
Tide	:	N/A
Recorder	:	DK
Site	:	Broad zonation

classify the features using the classification system and data recording cards from the handbook.

So, for the example in Figure 3, the procedure is as follows:

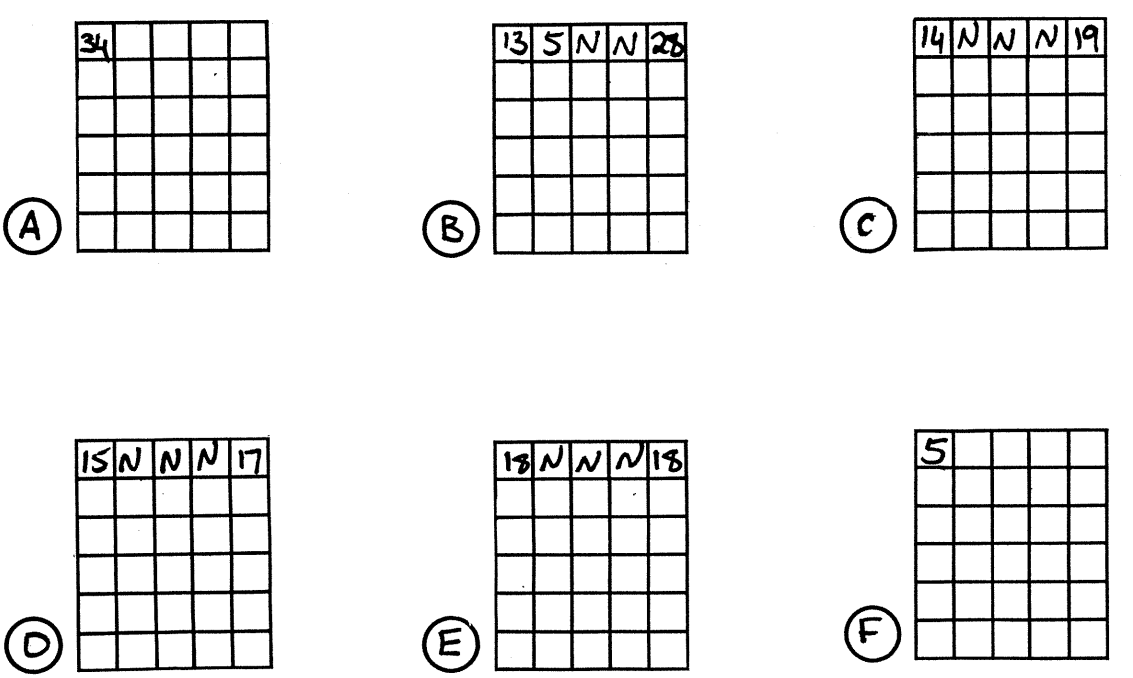
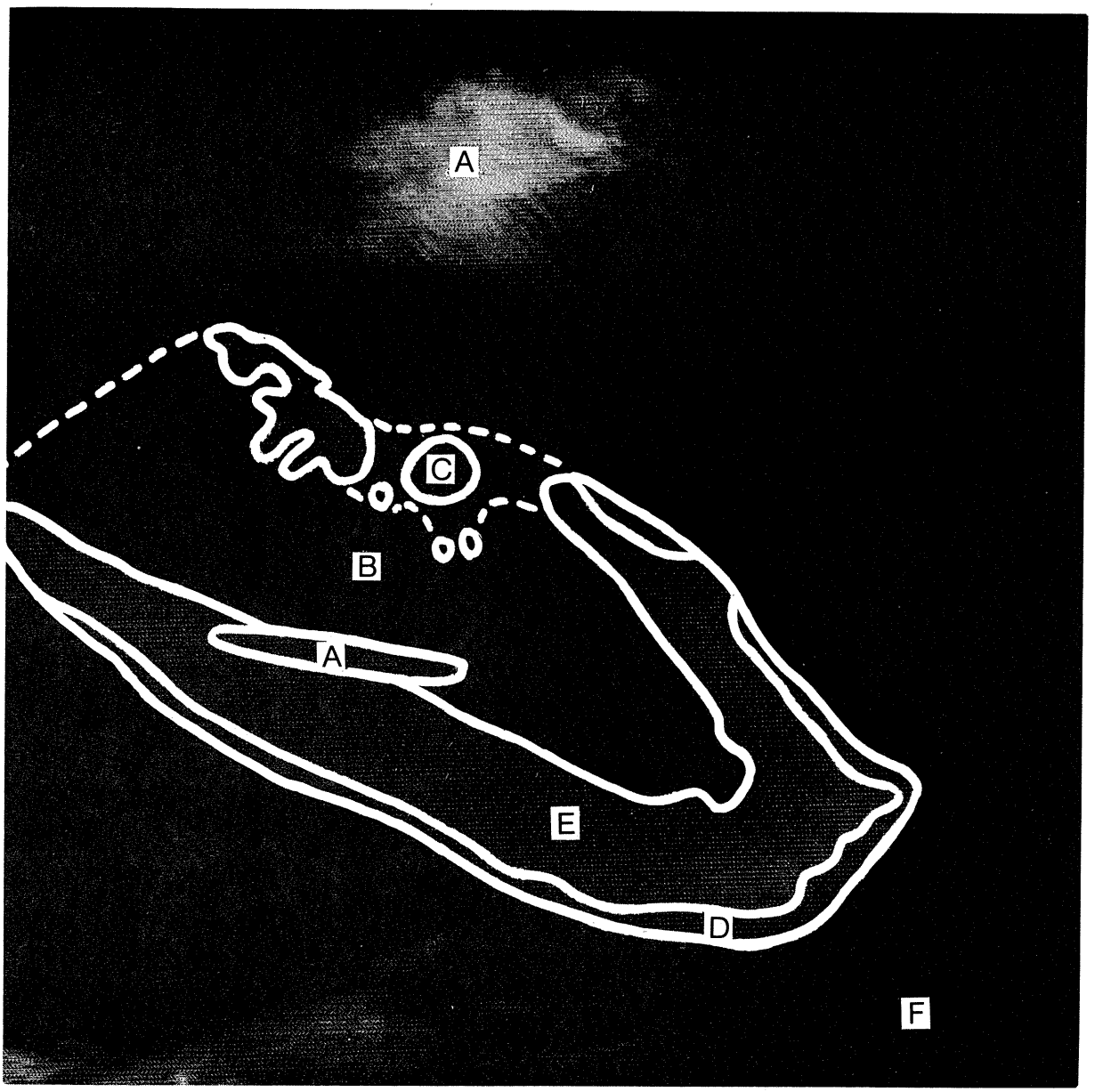


Figure 3. Landsat MSS image of Cairns Reef, GBR.

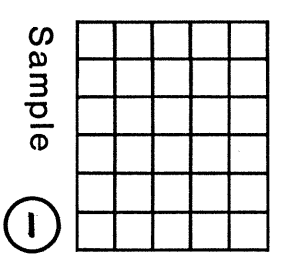


Example 5.2

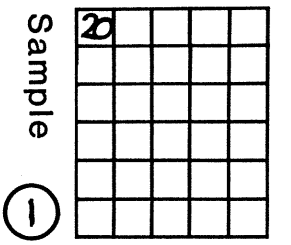
This example is based on the aerial photograph of Green Island which makes up Figure 5.

Figure 4. Flow-diagram illustrating the use of the classification system with a recording card.

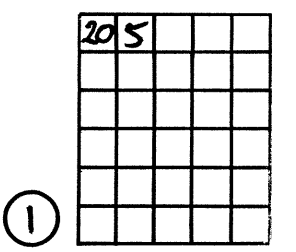
For this example, PCS = Primary categorising structure;
and SCS = Secondary categorising structure.

Instructions	Use of data recording card
START	
record information at top of data recording card	DRC No. : 1 Date : 4.4.83 Reef : Green Island Time/type: Aerial photo Tide : 1 m Recorder : DK Site : 1
record sample number in circle at bottom left of grid	
actively survey sample site for zonation and reef cover	
go to Level I	
read each entry	
PCS select one entry	20-Inner reef flat

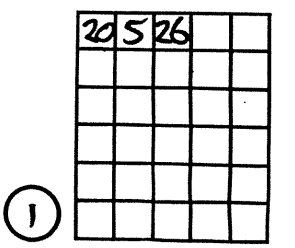
record entry using its numeric label in the top left grid cell



SCS	scan Level I to determine any other entries for use	Yes
	if Yes, MENTALLY note them	26-Seagrass zone
	go to Level II	
	read each entry	
PCS	select one entry	5-Slope
SCS	scan Level II to determine any other entries for use	No
	if Yes, MENTALLY note them	
PCS	record one entry from Level II in second column of row one	



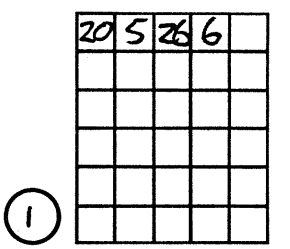
	go to Level III	
	read each entry	
PCS	select one entry	26-Sand
SCS	scan Level III to determine any other entries for use	No
	if Yes, MENTALLY note them	
PCS	record one entry from Level III in third column of row one	



go to Level IV

read each entry

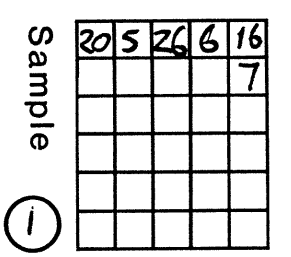
PCS	select one entry	6-Gentle
SCS	scan Level IV to determine any other entries for use	Yes
	if Yes, MENTALLY note them	27-Medium grained
	if No, continue	
PCS	record one entry from Level IV in column four of row one	



go to Level V

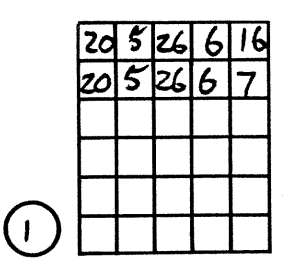
read each entry

SCS	select one or more entries	16-0.5 to 1.0 m 7-20 to 30%
SCS	record entries from Level V in column five of row one	



PCS if more than one Level V category is recorded, complete the primary classification structure for each category by repeating the Level I to IV categories in successive rows

go back to Level I entries



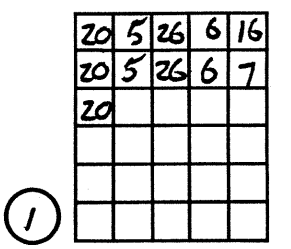
SCS

select any other categories from Levels II to IV which need to be recorded in relation to the current Level I entry

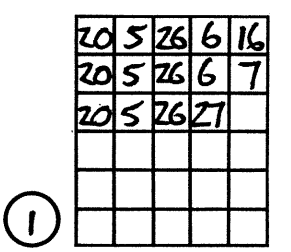
Yes, Level IV
27-Medium grained

if Yes, complete 1 to 5 below
if No, skip steps 1 to 5

1. repeat current Level I entry

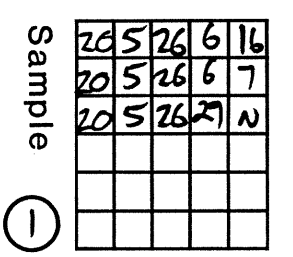


2. make another recording for any of the Levels II to IV or repeat current entries



3. make as many entries as are necessary for Level V

4. if more than one Level V category is recorded, complete the primary classification for each category by repeating the Level I to V categories



5. find any other categories from Levels II to V which need to be recorded in relation to the current Level I entry

No

if Yes, return to step 1
if No, continue

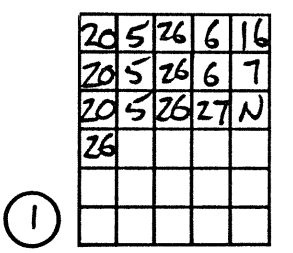
go back to Level I categories

SCS select any other entries to recall from memory for Level I — Yes
26-Seagrass zone

if Yes, continue reiteration process
if No, classification is complete

Reiteration process

record an entry from Level I in column one of next row available

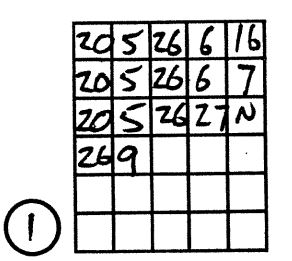


select entry from Level II — 9-Coral head

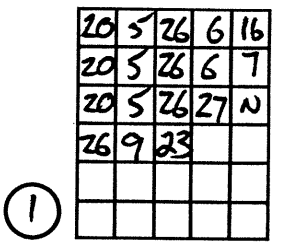
SCS scan Level II for other entries for use — Yes

if Yes, MENTALLY note them — 26-Sand patch

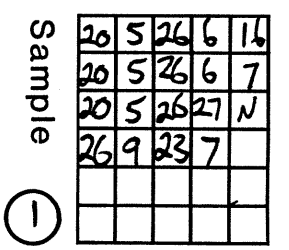
record the entry from Level II in column two



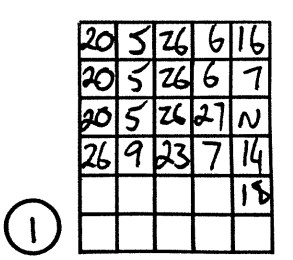
SCS	select one entry from Level III	23-Coral
SCS	scan Level III for other entries for use	No
	if Yes, MENTALLY note them	
	record one entry for Level III	



SCS	select one entry from Level IV	7-Live state
SCS	scan Level IV for other entries for use	No
	if Yes, MENTALLY note them	
	record one entry for Level IV	

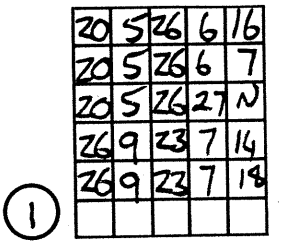


SCS	select one or more entries from Level V	14-90 to 100% 18-2 to 3 m
SCS	record all entries from Level V	
PCS	if more than one Level V category has been recorded, repeat all previous entries for Levels I to IV	



go back to Level I entry

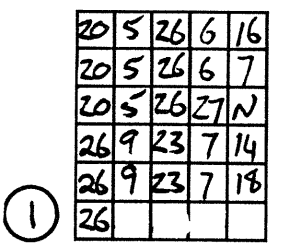
locate any other categories from Levels II to IV which must be recorded in relation to the current Level I entry



Yes
Level II - 26-Sand patch
Level III - 26-Sand
Level IV - 18-Circular
Level V - 2 to 3 m

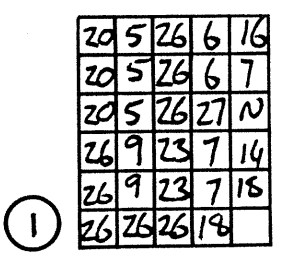
if Yes, complete 1 to 5 below
if No, skip steps 1 to 5

1. repeat current Level I entry

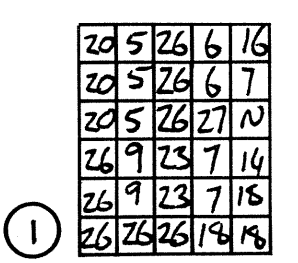


2. make another recording for any of the Levels II to IV, or repeat their current entries

3. make as many entries as are necessary for Level V



4. if more than one Level V category is recorded, complete the primary classification for each category by repeating all other Levels



5. locate any other categories from Levels II to V which must be recorded in relation to the current Level I entry

Yes

Level III - 22-Seagrass

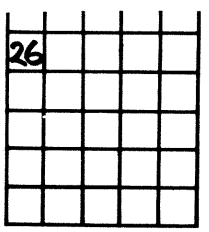
Level IV - 12-Patched Pn

Level V - 14-90%

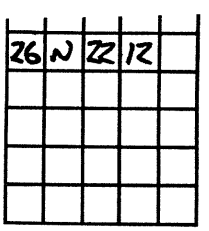
- 19-3 to 4 m

if Yes, complete 1 to 5 below
if No, skip steps 1 to 5

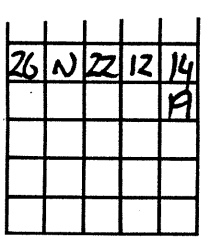
1. repeat current Level I entry



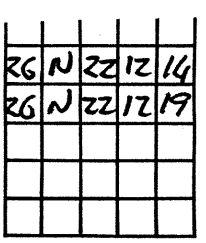
2. make another recording for any of the Levels II to IV, or repeat current entries



3. make one or more recordings for Level V



4. if more than one Level V category is recorded, complete the primary classification for each category by repeating the Level I to IV categories,



5. locate any other categories from Levels II to V which must recorded in relation to the current Level I entry

No

if Yes, go back to step 1
if No, continue

go back to Level I categories

SCS locate any other entries
to recall from memory for
Level I No

if Yes, work through the reiteration process
if No, classification is complete

END

Figure 5. Aerial photograph of Green Island Cay (GBR) and surrounding reef flat. Sample site 1 is delineated.

6. CONCLUSION

A user guide and handbook is now available for the reef cover and zonation classification system which is designed for use with remotely sensed Great Barrier Reef data. The guide outlines how to use the classification system efficiently and easily.

7. ACKNOWLEDGEMENTS

The Great Barrier Reef Marine Park Authority is acknowledged for its full financial support. Dr D.L.B. Jupp and Dr P. Laut of CSIRO, Division of Water and Land Resources, Canberra, kindly read the manuscript and offered constructive criticisms.

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