1 INTRODUCTION

1.1 INTRODUCTION

The Sustainable Development Unit (SDU) of the Hong Kong Special Administrative Region Government (HKSAR) has commissioned ERM-Hong Kong, Ltd (ERM) to undertake the study entitled **Terrestrial Habitat Mapping and Ranking Based on Conservation Value.** ERM is supported in this study by Dr Ng Sai-chit, Hong Kong' s leading expert in terrestrial ecology and floral identification, David Lau, an acknowledged vegetation specialist and Professor Xin Fu Wu of the South China Institute of Botany, The Chinese Academy of Sciences, a vegetation expert of the South China region. This study, awarded under the Tender Ref DAU/11/2002, shall henceforth be referred to as the Study.

The Study commenced on 16 September 2002, field surveys started in November 2002 and were completed in early April 2003. This *Final Report* is the fifth product of this Study and represents a product of Task 5 (Reporting) of the overall methodology for the Study (*Figure 1.1a*). This report provides descriptions of the review of the previous habit mapping exercise(1) with details on the discrepancies and information gaps identified in the existing database to be filled under this Study. This report also includes discussion on the finalisation of habitat mapping categories, conservation ranking, effort allocation strategy and survey methodology. The results of the field surveys undertaken for this Study and key findings of habitat mapping and conservation assessment are discussed and documented in this report.

1.2 BACKGROUND TO THE STUDY

In June 1998, an Environmental Baseline Survey on Terrestrial Habitat Mapping and Ranking Based on Conservation Value was commissioned by the Planning Department (PlanD) of the HKSAR Government, under a Supplementary Agreement to the Study of Sustainable Development 21st Century (SUSDEV 21). The study, conducted by ERM, was designed to update an existing Hong Kong-wide vegetation map, to expand the coverage to include new categories, and to present the results in an interactive Geographic Information System (GIS). The study was also designed to develop a system for ranking the conservation value of areas of Hong Kong, to supplement the compilation of existing conservation data through field surveys, and to present the results in a GIS.

(1) ERM-Hong Kong, Ltd (2000) Study on Sustainable Development for the 21st Century: Environmental Baseline Survey on Terrestrial Habitat Mapping and Ranking Based on Conservation Value. Final Report to the Planning Department.

The mapping and ranking exercise executed for the SUSDEV 21 baseline survey produced a comprehensive and robust habitat mapping system which is believed to be a fundamental tool for planning future development in Hong Kong. The habitat map, which forms one of the GIS layers available on the Computer-Aided Sustainability Evaluation Tool (CASET) System, allows users to display different map themes and assist in visualisation of the effects of proposed changes. The habitat mapping system is particularly useful in acting as a tool for quantification and assessment of existing natural habitats. The conservation ranking information provided in the system facilitates sustainable development planning by highlighting important areas for protection and evaluating the existing baseline conditions against any indicators (developed under the SUSDEV 21 Study) involving the area of land with various levels of conservation status. The study was completed in August 2000 and the key findings were documented(1).

1.3 OBJECTIVES OF THE STUDY

According to the Tender Brief, the main objectives of the present Study are to update the findings of the previous Study through field surveys and to update the terrestrial ecological baseline data. To fulfil the study objectives, the methodology and key findings of the previous Study have been thoroughly reviewed to identify discrepancies, uncertainties and outstanding information gaps. A field survey proposal with details on survey methodology, sites to be visited and survey programme to fill the information gaps was recommended; habitat mapping and conservation value field surveys (a total of 200 days) were conducted by ecology specialists to obtain necessary field information for updating the ecological baseline database. The field data so collected were carefully validated and analysed before inputting the information into the database and updating the interactive GIS habitat and conservation value maps contained in the CASET.

1.4 REPORT STRUCTURE

The remainder of the report is set out as follows:

- *Section 2* presents the results of the review of existing database and findings of the previous Study with details on the definitions of habitat categories mapped on the existing habitat map and the conservation ranking system;
- *Section 3* provides a review of the existing database to identify information gaps to be filled by field surveys and the strategy of survey effort allocation on the habitat categories;
- *Section 4* details the survey methodology employed for each selected habitat type with specifications on the information collected and location of the selected sites;

(1) ERM-Hong Kong, Ltd (2000) *Op cit.*

- *Section 5* presents the key findings of field surveys and details of the survey schedule for each habitat type, and the work programme of this Study;
- *Section 6* presents the results of overall mapping accuracy and conservation value ranking, and changes in the total area of each habitat type and conservation value ranking; and
- *Section 7* provides the summary and conclusions of the *Final Report*.

2 REVIEW OF PREVIOUS FIELD SURVEY DATABASE AND HABITAT MAPPING CATEGORIES

2.1 INTRODUCTION

This Section provides information from the review of the database compiled under the previous Study with a focus on habitat category definitions and indicative ecological value. Findings of the previous Study have been reviewed to identify discrepancies, uncertainties and outstanding information gaps. The focus of the review is on the recommendations provided in the *Final Report* of the previous Study on information gaps that are yet to be filled (see "Information Gaps Filled by Previous Surveys" and "Gaps Yet to be Filled by Field Surveys" of *Table 2.1*). Appropriate specialists have also been consulted during the review process to ensure that a comprehensive identification of outstanding information gaps and discrepancies is undertaken.

2.2 HABITAT CATEGORIES

Under the previous Study habitat categories were developed based on the list of land use categories plotted on the WWF habitat map and refined based on the comments received from the Government Departments, and consultation with Hong Kong University (HKU) Biodiversity Survey Team specialists and satellite imagery/aerial photograph experts. At the inception of the previous Study a total of 34 vegetation and land use categories were taken from the WWF map and were generalised to an extent into 27 broader classes. These classes were believed at the time to be more useful and were supplemented by additional categories to cover coastal areas and more specific land uses such as fishponds and landfills. This list of habitat mapping categories was further revised based on comments received from Government, and consultation with HKU Biodiversity Survey Team specialists and satellite imagery/aerial photograph experts.

At the request of Water Supplies Department, the category "Reservoir" was moved as an individual category and mapped under the category "Modified Watercourse". The list of habitat mapping categories was further revised based on comments received from Government, and consultation with HKU Biodiversity Survey Team specialists and satellite imagery/aerial photograph experts. As the "Buildings" category could not be successfully identified using classification techniques for preparing the preliminary habitat map, the category was subsumed into the "Other" category. The amendment was considered unlikely to have an effect on the objective of habitat mapping since both categories were indicatively assigned an ecological value of "negligible". Therefore, a total of 25 categories were mapped on the habitat map. Photographs of each of these habitat types (with high, medium or low indicative ecological value) are presented in *Figures 2.2a – c.*

2.2.1 Definitions of Habitat Mapping Categories

The definitions of the mapping categories were considered pertinent in providing guidelines for satisfactory mapping of habitats through supervised classification and usage of existing information. Definitions for the 25 habitat categories are summarised in *Table 2.2*.

Table 2.2 Definitions of Habitat Mapping Categories

Habitat/Feature Type	Mapping Category	Definitions
Natural Terrestrial Habitats	Bare Rock or Soil	Naturally open rock faces or disturbed lands, or "badlands" denuded of vegetation.
	Grassland	Lands covered predominantly (50% or more) by grasses with no visible woody plants.
	Shrubby Grassland	Lands covered predominantly (50% or more) by grasses and contained visible woody plants covering up to 50% of the area.
	Mixed Shrubland	Lands covered with less than 50% grasses with shrubs the major woody life form.
	Baeckea Shrubland	Lands covered with less than 50% grasses with the genus *Baeckea* (Myrtaceae) the predominant plant group.
	Fung Shui Forest	Lands covered with natural forests over 60 years old and dominated by native species. Often located behind villages, in valleys or near water.
	Montane Forest	Lands covered with natural forests above 600m above sea level.
	Lowland Forest	Lands covered with natural forests below 600m above sea level.
	Plantation or Plantation /Mixed Forest	Lands covered with tree species varying in size from low saplings to mature trees, which are in recognizable rows from the air. Areas where the definition of "in recognizable rows from the air" cannot apply (eg plantations have become mixed plantation forests and intermingled with other spectrally and visually habitats, making identification using satellite imagery and aerial photos impossible) and require field surveys to supplement the mapping, the pattern in and type of plant species used for tree planting site formed the basis for justification of this habitat.
Natural/Artificial Freshwater and Intertidal Habitats	Freshwater/ Brackish Wetland	Lands covered with shallow waters and dominated by emergent hydrophytes.
	Natural Watercourse	Consists of rivers and streams experiencing natural flow patterns in unchannelised beds and banks.
	Modified Watercourse	• Consists of channelised rivers, streams and other waterbodies, which are often without natural banks and beds, and are not subject to a natural flow patterns (eg drainage channels, nullahs and reservoirs). • Rivers with substantial abstraction of water for irrigation or domestic use. • Watercourse with "very bad" water quality identified by EPD.

Habitat/Feature Type	Mapping Category	Definitions
	Fishpond/Gei wai	• Fishponds are small artificial lakes that have been constructed for the purposes of growing freshwater fish. • Gei wais are small artificial lakes which contain brackish water and are often flushed through tidal action.
	Mangrove	Highly productive intertidal areas that support high biological diversity and which are know as breeding and nursery grounds for a range fauna.
	Intertidal Mudflat	Areas of fine-grained sediment (ie silt or finer) which lie between the high and low tide marks and which are not covered by seagrasses, mangroves or typical wetland vegetation.
	Seagrass Bed	Shallow intertidal or subtidal areas dominated by one or more species of specialised marine grasses.
	Sandy Shore	Areas of sandy sediment (coarser than silt and up to and including cobble-sized rocks) between the high and low tide marks, and areas with 50% or more of the area consists of exposed sand or rocks equal to or smaller than cobbles.
	Rocky Shore	Areas of stable (non-mobile) rocks larger than cobbles between the high and low tide marks, covering more than 50% of the area.
	Artificial Rocky/Hard Shoreline	Man-made intertidal hard shore habitats, eg seawalls, jetties, groins and piers.
Disturbed Areas which Provide Some Habitat	Cultivation	Lands currently under cultivation, ie actively agricultural land (eg rice paddies or areas farmed for vegetables), and lands not currently under cultivation and/or abandoned for cultivation.
	Golf Course/Urban Park	• Areas which consist of existing golf courses and urban parks, and areas under development for golf courses and urban parks. • Urban parks include all recreational parks under the governmental management, and non-governmental management of private enterprises.
Disturbed Areas which Provide Little if any Habitat	Rural Industrial Storage/Containers	Areas in which large number of containers or other commercial/industrial materials are stored (generally considered as "black spot" areas by the Government).
	Quarry	Areas which are being or have been excavated for rock.
	Landfill	Areas used for disposal of solid waste and may be either active or inactive.
	Other[a]	Areas occupied by urban or other highly modified habitats, including scattered buildings mixed with cultivation, abandoned cultivation and/or forest.

a: Definitions of the habitat have been modified to include the "Buildings" category.

2.2.2 *Indicative Designation of Ecological Value*

Each identified habitat type was assigned an indicative ecological value of either high, medium, low or negligible. These ecological values were defined with reference to elements of *Annex 8: Criteria for Evaluating Ecological Impact, EPD Technical Memorandum on the Environmental Impact Assessment Process* (*EIAO TM*).

High ecological value habitat was defined as:

- areas which support the highest known biodiversity values for Hong Kong; or
- areas which are documented to function as important breeding, nursery or key foraging habitats; or
- areas which contain habitats that are regionally rare or threatened or provide documented critical habitat for "rare" species; or
- areas which contain unusually large-sized, valuable and generally undisturbed habitat.

Medium ecological value habitat was defined as:

- areas which support intermediate biodiversity values for Hong Kong; or
- areas which may provide critical habitat for "rare" species but for which such use is not documented; or
- areas which may function as important breeding, nursery or key foraging habitats but for which such use is not documented; or
- areas which contain unusually large-sized and valuable habitats which have been fragmented or otherwise disturbed such that habitat potential has diminished; or
- areas which have potential to develop into high value habitat but do not meet the criteria for high ecological value at present.

Low ecological value habitat was defined as:

- areas which support low biodiversity values for Hong Kong; or
- areas which are not likely to provide critical habitat for "rare" species; or
- areas which are not likely to function as important breeding, nursery or key foraging habitats; or
- areas which contain habitats that have been degraded or modified by human activities such that habitat potential is low but that can be recolonized by the original floral/faunal assemblage; or
- areas which have potential to develop into medium value habitat but do not meet the criteria for medium ecological value at present.

Negligible ecological value habitat was defined as:

- areas which support negligible biodiversity values for Hong Kong; or
- areas which do not provide critical habitat for "rare" species; or
- areas which do not function as important breeding, nursery or key foraging habitats; or
- areas which contain habitats that have been severely degraded or extensively modified by human activities such that habitat potential is negligible and recolonization by the original floral/faunal assemblage is unlikely; or
- areas which do not have potential for developing into high, medium or low value habitat in the foreseeable future.

In assigning each of the habitat categories either high, medium, low or negligible ecological value, a number of criteria (biodiversity, support of rare species, ecological function, rarity, vulnerability, size and potential) were assessed. However, the overall assessment was based on the classification which best represented the habitat type rather than on strict compliance with each of the criteria under a particular classification. It is also acknowledged that specific sites within a given habitat category may vary in ecological value. The habitats classified as of high value ecological habitat included:

- Fung Shui Forest
- Montane Forest
- Lowland Forest
- Mixed Shrubland
- Freshwater/Brackish Wetland
- Natural Watercourse
- Mangrove
- Seagrass Bed
- Intertidal Mudflat

The habitats classified as of medium value ecological habitat included:

- Shrubby Grassland
- *Baeckea* Shrubland
- Plantation or Plantation/Mixed Forest
- Fishpond/Gei Wai
- Sandy Shore
- Rocky Shore
- Cultivation

The habitats classified as of low value ecological habitat included:

- Bare Rock or Soil
- Grassland
- Modified Watercourse
- Artificial Rocky/Hard Shoreline
- Golf Course/Urban Park
- Quarry

The habitats classified as of negligible value ecological habitat included:

- Rural Industrial Storage/Containers
- Landfill
- Other

Figure 2.2d illustrates the mapping of ecological value in Hong Kong as reported in the previous Study.

2.2.3 Suitability of Habitat Categories & Ecological Value Classifications

The suitability of using the previous Study' s habitat categories was examined during the review and it was concluded that in general no modifications were required. Through maintaining the same categories and classifications more consistency between the two studies will be achieved. However, based on the field survey results obtained from the previous Study for *Baeckea* Shrubland, the habitat showed a comparatively low mapping accuracy (38.1%) and the majority of the mis-identified habitats were actually Mixed Shrubland or Shrubby Grassland.

As Shrubby Grassland and *Baeckea* Shrubland have the same indicative ecological value of medium (see *Section 3.2.2*) and based on comments received at the kick-off meeting (23 September 2002), it was considered appropriate to modify the definition of Shrubby Grassland to include the "*Baeckea* Shrubland" category. The definition for Shrubby Grassland is revised as "Lands covered predominantly (50% or more) by grasses and/or with the genus *Baeckea* (Myrtaceae), and containing visible woody plants covering up to 50% of the area." The resulting habitat map will thus show a total of 24 habitat categories.

Based on the comments from AFCD(1), a forest must have Fung Shui function to the villages, either at present and at least in the past, to be qualified as a Fung Shui Forest. It was therefore considered appropriate to revise the definition of Fung Shui Forest to incorporate the "Fung Shui" elements.

(1) Memo dated 16th April 2003.

It is also considered appropriate to maintain the indicative ecological value classifications assigned to each of the mapped habitat categories as in the previous Study. Consequently, no modification to the indicative designation is required.

Table 2.3 shows the revised habitat categories and their definitions and corresponding indicative ecological values.

Table 2.3 Revised Habitat Categories and their Definitions and Corresponding Indicative Ecological Values

Habitat Category	Definitions	Indicative Ecological Value
Bare Rock or Soil	Naturally open rock faces or disturbed lands, or "badlands" denuded of vegetation.	Low
Grassland	Lands covered predominantly (50% or more) by grasses with no visible woody plants.	Low
Shrubby Grassland (including *Baeckea* Shrubland)	Lands covered predominantly (50% or more) by grasses and/or with the genus *Baeckea* (Myrtaceae), and contained visible woody plants covering up to 50% of the area.	Medium
Mixed Shrubland	Lands covered with less than 50% grasses with shrubs the major woody life form.	High
Fung Shui Forest	Lands covered with natural forests over 60 years old, dominated by native species and possessed Fung Shui function to the villages, either at present or in the past. Often located behind villages, in valleys or near water.	High
Montane Forest	Lands covered with natural forests above 600m above sea level.	High
Lowland Forest	Lands covered with natural forests below 600m above sea level.	High
Plantation or Plantation /Mixed Forest	Lands covered with tree species varying in size from low saplings to mature trees, which are in recognizable rows from the air. Areas where the definition of "in recognizable rows from the air" cannot apply (eg plantations have become mixed plantation forests and intermingled with other spectrally and visually habitats, making identification using satellite imagery and aerial photos impossible) and require field surveys to supplement the mapping, the pattern in and type of plant species used for tree planting site formed the basis for justification of this habitat.	Medium
Freshwater/ Brackish Wetland	Lands covered with shallow waters and dominated by emergent hydrophytes.	High
Natural Watercourse	Consists of rivers and streams experiencing natural flow patterns in unchannelised beds and banks.	High

Habitat Category	Definitions	Indicative Ecological Value
Modified Watercourse	• Consists of channelised rivers, streams and other waterbodies, which are often without natural banks and beds, and are not subject to a natural flow patterns (eg drainage channels, nullahs and reservoirs). • Rivers with substantial abstraction of water for irrigation or domestic use. • Watercourse with "very bad" water quality identified by EPD.	Low
Fishpond/Gei wai	• Fishponds are small artificial lakes that have been constructed for the purposes of growing freshwater fish. • Gei wais are small artificial lakes which contain brackish water and are often flushed through tidal action.	Medium
Mangrove	Highly productive intertidal areas that support high biological diversity and which are know as breeding and nursery grounds for a range fauna.	High
Intertidal Mudflat	Areas of fine-grained sediment (ie silt or finer) which lie between the high and low tide marks and which are not covered by seagrasses, mangroves or typical wetland vegetation.	High
Seagrass Bed	Shallow intertidal or subtidal areas dominated by one or more species of specialised marine grasses.	High
Sandy Shore	Areas of sandy sediment (coarser than silt and up to and including cobble-sized rocks) between the high and low tide marks, and areas with 50% or more of the area consists of exposed sand or rocks equal to or smaller than cobbles.	Medium
Rocky Shore	Areas of stable (non-mobile) rocks larger than cobbles between the high and low tide marks, covering more than 50% of the area.	Medium
Artificial Rocky/Hard Shoreline	Man-made intertidal hard shore habitats, eg seawalls, jetties, groins and piers.	Low
Cultivation	Lands currently under cultivation, ie actively agricultural land (eg rice paddies or areas farmed for vegetables), and lands not currently under cultivation and/or abandoned for cultivation.	Medium
Golf Course/Urban Park	• Areas which consist of existing golf courses and urban parks, and areas under development for golf courses and urban parks. • Urban parks include all recreational parks under the governmental management, and non-governmental management of private enterprises.	Low
Rural Industrial Storage/Containers	Areas in which large number of containers or other commercial/industrial materials are stored (generally considered as "black spot" areas by the Government).	Negligible
Quarry	Areas which are being or have been excavated for rock.	Low
Landfill	Areas used for disposal of solid waste and may be either active or inactive.	Negligible
Other	Areas occupied by urban or other highly modified habitats, including scattered buildings mixed with cultivation, abandoned cultivation and/or forest.	Negligible

2.3 *CONSERVATION VALUE RANKING SYSTEM*

In addition to the ecological value classifications, the habitat base map also included an asterisk ("*") to indicate that the area has one or more unique features which distinguish it from other areas in the same category. A conservation ranking system incorporating ecological, heritage, recreation and landscape conservation components was proposed in the previous Study to consist of high, medium, low and negligible ecological values outline above. These conservation rankings were assigned to areas whose boundaries are defined by their habitat type and ecological value. The same conservation ranking system was recommended for use in the present Study and modification to the ranking system was considered not necessary.

3 SURVEY EFFORT ALLOCATION

3.1 INTRODUCTION

The Tender Brief required that a total of 200 days of effort were allocated to field surveys. To effectively utilise the field survey days, a strategy for effort allocation was devised to ensure maximum utilisation of survey days, and that valuable and representative information was collected from target sites of selected habitats by the members of the Field Survey Team. The strategy adopted in the previous Study was reviewed and where appropriate, modifications to the approach were proposed (1) to suit the purpose of the present Study.

To assign survey effort to each habitat type, an approach similar to the one adopted under the previous habitat mapping exercise was adopted in the present Study. In addition to the factors that were considered in the previous Study (including the accuracy of the mapping, the ecological importance of habitats, and the availability of existing information on the habitat) for devising the effort allocation strategy, other factors, including the habitat mapping accuracy based on previous survey results and the area remaining un-surveyed were also included as criteria for effort allocation. As specified in the Tender Brief, more survey effort was allocated to land covering classes, which are considered to be of higher conservation value or were, under the previous Study, more difficult to map using remote sensing (eg satellite imagery). The information gaps from the previous Study have been reviewed (see *Table 2.1*) and the effort allocation has taken this into consideration such that the information gaps can be filled as far as possible. Details of survey effort allocation are described in the following sections and depicted in *Figure 3.1a*.

3.2 REVIEW OF EFFORT ALLOCATION OF THE PREVIOUS STUDY

According to *Topic Report 2* of the previous Study(2), survey days were initially assigned for three purposes including:

- General Verification;
- Supplemental Verification; and
- Ecological Value (Conservation) Assessment.

(1) ERM- Hong Kong, Ltd (2002) Terrestrial Habitat Mapping and Ranking Based on Conservation Value. Topic Report on Habitat Mapping Survey for the Sustainable Development Unit.

(2) ERM-Hong Kong, Ltd (1999) Study on Sustainable Development for the 21st Century: Environmental Baseline Survey on Terrestrial Habitat Mapping and Ranking Based on Conservation Value. Topic Report 2 – Proposal for Field Surveys to the Planning Department.

In addition to these criteria for effort allocation, additional factors including mapping accuracy based on previous field survey results and area coverage of habitats, were included for consideration in the present Study.

As there was only one patch of Plantation or Plantation/Mixed Forest identified initially on the habitat map and field surveys have been undertaken on the mapped habitat, no survey effort was allocated to this habitat category under the present Study.

3.2.1 General Verification

In the previous Study, limited survey effort was allocated for General Verification which involved groundtruthing of the habitat for the purpose of "spot-checking", even if the interpretation of the satellite imagery and aerial photographs is valid given the desktop information available. The purpose of these limited surveys was to confirm, through further groundtruthing, the accuracy of the habitat type classification and the boundary of the habitat. One survey day effort for General Verification was assigned to habitat categories that have an indicative ecological value of high, medium or low value.

Modifications: According to the Tender Brief, more survey effort should be allocated to land covering classes which are of higher conservation value. Therefore, no survey effort was devoted to habitats that have a lower than medium (ie low and negligible) indicative ecological value. Habitats that had been assigned one day of effort for this purpose included the following:

High value ecological habitats:

- Fung Shui Forest
- Montane Forest
- Lowland Forest
- Mixed Shrubland
- Freshwater/Brackish Wetland
- Natural Watercourse
- Mangrove
- Seagrass Bed
- Intertidal Mudflat

Medium value ecological habitats:

- Shrubby grassland (including *Baeckea* Shrubland)
- Plantation or Plantation/Mixed Forest
- Fishponds/Gei Wais
- Sandy Shore
- Rocky Shore
- Cultivation

One day of survey effort was allocated to each of the above categories for general habitat verification for a total of 16 days (see *Figure 3.2a*). No survey efforts were allocated to low (ie Bare Rock or Soil, Grassland, Modified Watercourse, Artificial Rocky/Hard Shoreline, Golf Course/Urban Park and Quarry) and negligible value habitats (ie Rural Industrial Storage/Containers, Landfill and Other (urban or other highly modified habitats)).

3.2.2 Supplemental Verification

The purpose of the supplemental verification survey allocation was to devote additional effort to groundtruthing habitat types for which the previous satellite imagery and aerial photograph methodology could not easily distinguish boundaries and value. The mapping confidence of each habitat category of the preliminary habitat map was assessed in the previous Study with regard to the habitat type and boundary and a graded level of mapping confidence was assigned to individual mapping categories. Confidence rating of high, medium and low was defined as follows:

- **High** level of confidence indicates that most of the identified areas of the habitat category are expected to have been accurately mapped with very few unconfirmed locations;
- **Medium** level of confidence indicates that the habitat' s high natural variability has resulted in uncertainties regarding the classification of some of the areas assigned to this habitat type; and
- **Low** level of confidence indicates that the habitat category is classified with high uncertainties such that the classification should be groundtruthed for as many sites as possible.

The mapping confidence of the preliminary habitat map and the overall mapping accuracy of different habitat types based on field surveys in the previous Study are summarised in *Table 3.1*.

Table 3.1 Mapping Confidence of Preliminary Habitat Map and Mapping Accuracy of Each Habitat Type Based on Field Surveys in the Previous Study

Habitat Type	Mapping Confidence of Preliminary Habitat Map	Mapping Accuracy based on Field Surveys (Previous Study)
Indicative Ecological Value – High		
Fung Shui Forest[b]	Medium	N/A
Montane Forest	Medium	41.3
Lowland Forest	Low	69.9
Mixed Shrubland	Low	60.4
Freshwater/Brackish Wetland	Low	21.4
Natural Watercourse	Medium	85.0
Seagrass Bed[b]	High	N/A
Mangrove	High	92.5
Intertidal Mudflat	Medium	73.2

Habitat Type	Mapping Confidence of Preliminary Habitat Map	Mapping Accuracy based on Field Surveys (Previous Study)
Indicative Ecological Value – Medium		
Shrubby Grassland	Medium	25.1
Baeckea Shrubland	Low	38.1
Plantation or Plantation/Mixed Forest	High	100.0
Fishpond/Gei Wai	High	55.7
Sandy Shore[c]	High	96.6
Rocky Shore[c]	High	100.0
Cultivation	Medium	80.8
Indicative Ecological Value – Low		
Bare Rock or Soil	High	44.8
Grassland	Medium	27.3
Modified Watercourse	Medium	95.4
Artificial Rocky/Hard Shoreline[c]	High	100.0
Golf Course/Urban Park	High	95.0
Quarry	High	94.1
Indicative Ecological Value – Negligible		
Rural Industrial Storage/Containers[d]	High	N/A
Landfill[d]	High	N/A
Other (Urban or Other Highly Modified Area)[d]	Medium	N/A

Note:
The 100% mapping accuracy obtained for Plantation or Plantation/Mixed Forest was due to the fact that only one location has been successfully identified under the category using the methodology adopted for mapping the habitat and field surveys showed that the area mapped was 100% correct. Field surveys on other habitat types, such as Lowland Forest and Mixed Shrubland, of the previous Study have picked up some more plantations.

b: The habitat was represented as dot locations on the preliminary base map and therefore was not applicable for spatial calculation.

c: The habitat (or majority of it) was mapped as a linear component, the total "area" surveyed for the habitat is represented by the length (km) of the habitat.

d: No field surveys were conducted for the habitat and therefore mapping accuracy based on field surveys is not available.

Habitats which have been mapped with less than a high level of mapping confidence, except for those which have a negligible indicative ecological value, have been allocated additional survey effort to verify their habitat type and boundary.

An additional **two** days of verification time was allocated to those habitat categories, which have been regarded as having a medium level of mapping confidence whereas for habitats with low mapping accuracy, an additional **four** days were assigned.

Modifications: As specified in the Tender Brief, more survey effort should be allocated to land covering classes which are of higher conservation value or are more difficult to map using remote sensing (eg satellite imagery).

Therefore, as with General Verification, no additional survey effort had been devoted to habitats that have a lower than medium (ie low and negligible) indicative ecological value for the purpose of Supplemental Verification. Habitats that have been assigned 2 days of effort for this purpose include the following:

- Fung Shui Forest
- Montane Forest
- Natural Watercourse
- Intertidal Mudflat
- Shrubby Grassland (including *Baeckea* Shrubland)
- Cultivation

Habitats with low mapping accuracy will require even more effort in verifying their habitat type and boundary. Therefore, an additional 4 days have been allocated to the following categories:

- Mixed Shrubland
- *Baeckea* Shrubland (being classified under Shrubby Grassland)
- Lowland Forest
- Freshwater/Brackish Wetland

Ecological Value Assessment: As discussed above the indicative designation of ecological value for each habitat was based on the overall assessment of the category against a number of criteria (including biodiversity, support of rare species, ecological function, rarity, vulnerability, size and potential). However, specific sites within a given habitat category may vary in ecological value due to variations in habitat structure, size, level of disturbance, and other factors. Therefore, it is desirable to validate the indicative ecological value for specific sites, especially when variability within a given habitat type is high.

The number of days to be allocated is assigned to each habitat class depending on that habitat' s ecological importance and the variability of the habitat type and boundary. Habitat variability refers to the likelihood that the sites mapped under a habitat category could be adjusted from the indicative ecological value. Four classes have been identified to assist in allocating the survey effort. The habitats assigned to each class and the proposed effort allocation are summarised in the *Table 3.2* below.

Table 3.2 ***Provisional Allocation of Survey Effort for the 4 Classes of Habitat Identified in Topic Report 2 of the Previous Study***

Class	Habitat Category	Effort Allocation (days)
High Ecological Value with High Variability	Lowland Forest	8
	Mixed Shrubland	8
	Freshwater/Brackish Wetland	8
	Natural Watercourse	8
High Ecological Value with Low Variability	Fung Shui Forest	5
	Montane Forest	5
	Mangrove	5
	Seagrass Bed	5
	Intertidal Mudflat	5
Medium Ecological Value with High Variability	Fishponds/Gei Wais	5
	Cultivation	5
Medium Ecological Value with Low Variability	Shrubby Grassland (incl. *Baeckea* shrubland)	6#
	Plantation or Plantation/Mixed Forest	3
	Sandy Shore	3
	Rocky Shore	3
	TOTAL	82 (of the overall total of 200 days)

3 days for Shrubby Grassland and 3 days for *Baeckea* Shrubland

Additional Effort Based on Field Survey Mapping Accuracy: Based on the results from the previous habitat surveys, the overall mapping accuracy ranged from 21.4% to 100%. It was considered appropriate to allocate additional survey effort to the habitat categories that have less than 70% accuracy. These habitats include:

- Montane Forest
- Lowland Forest
- Mixed Shrubland
- Freshwater/Brackish Wetland
- Shrubby Grassland (including *Baeckea* Shrubland)
- Fishponds/Gei Wais

It was proposed to add 2 survey days to each of the above habitats.

Additional Effort Based on High Coverage: Based on the area coverage of habitats identified on the conservation ranking assessment map, high ecological value habitats are mainly composed of lowland forest and mixed shrubland with respective percentage coverage of 16.3% and 14.7%. It was therefore proposed to allocate 2 additional survey days to each of the two habitat categories.

Re-adjustment of survey effort: Based on the previous Study and its resulting recommendations, the survey effort allocated to Montane Forest, Seagrass Bed and Plantation or Plantation/Mixed Forest has been proposed to re-allocate to other habitat categories. Though there are still some Montane Forest patches left unsurveyed, these habitats are mainly located on steep slopes or in ravine valleys where accessibility is very limited. It has, therefore, been recommended that further surveys on the habitat are not necessary given its small size and restricted accessibility. The 10 days originally assigned have been shifted to other categories for which uncertainty in ecological value and mapping is higher (see *Figure 3.2a*). Since the habitat value of the mapped Seagrass Bed habitats are well-documented based on existing information, the necessity for conducting surveys to validate the ecological value of the identified habitats is therefore low. It was therefore considered appropriate to re-assign the 6 survey days, initially allocated to the seagrass category, to other categories for which uncertainty in ecological value and mapping is higher (see *Figure 3.2a*).

For the plantation category, as there was only one patch mapped and surveyed under this category in the previous Study, so the 4 days of survey effort originally budgeted have been re-assigned to other more uncertain/higher ecological value categories (see *Figure 3.2a*). As it was agreed with SDU that the mapping of fishponds/gei wais would be undertaken through desktop checking using aerial photographs, therefore the 8 days of survey effort originally assigned to Fishpond/Gei Wai have been re-distributed to other habitat categories that are more uncertain and/or of higher ecological value (see *Figure 3.2a*). As a result, there were altogether 28 days (from Montane Forest, Seagrass Bed, Plantation or Plantation/Mixed Forest and Fishpond/Gei Wai) available for re-allocation.

Because of their high ecological value and variability, the "High Ecological Value with High Variability" categories, ie Lowland Forest, Mixed Shrubland, Freshwater/Brackish Wetland and Natural Watercourse, would benefit from additional effort in field surveying. Each of the four categories has therefore been allocated 3 more days for assessing their ecological value. Also, 2 more days have been allocated to high and medium ecological value habitats that have comparatively low mapping accuracy (< 70%) based on previous field survey results (ie Lowland Forest, Mixed Shrubland, Freshwater/Brackish Wetland and Shrubby Grassland (including *Baeckea* Shrubland)). Lowland Forest and Mixed Shrubland have been given 3 more days of effort as these two categories are of high percentage coverage on the habitat map. The remaining 56 survey days have been assigned to Fung Shui Forest (1 day), Lowland Forest (16 days), Mixed Shrubland (16 days), Natural Watercourse, (11 days), Mangrove (1 day), Shrubby Grassland (8 days), Rocky Shore (1 day) and Cultivation (2 days). The re-adjustment of survey effort is illustrated in *Figure 3.2a*.

Contingency Days: In the previous Study, there was a total of 6 days (out of 140 ecological survey days) reserved as a contingency for poor weather, unforeseen denied access or other unexpected circumstances. Based on the

experience of the previous Study, no contingency was triggered. Therefore, for the present Study, all the 200 days have been initially allocated to habitats rather than reserving any for contingency.

3.3 FINALISATION OF SURVEY EFFORT ALLOCATION

Information gaps from the previous Study have been reviewed and are presented in *Table 2.1*. The 200 days of effort allocated to each habitat following the processes detailed above in *Section 3.2* are presented in *Figure 3.2a* and summarised in *Table 3.3* below. Based on the resulting survey effort allocation, a total of 151 field survey days were assigned to seven habitat categories that are of high indicative ecological value and a total of 49 days were given to four medium indicative ecological value habitats (see *Table 3.3*). Habitat mapping of Fishpond/Gei Wai would be updated through desktop mapping verification using the latest available aerial photographs(1) .

Table 3.3 Survey Effort Allocation to Each Habitat Category

Habitat Category	No. of Field Days
High Indicative Ecological Value	
Fung Shui Forest	9
Lowland Forest	41
Mixed Shrubland	41
Freshwater/Brackish Wetland	20
Natural Watercourse	25
Mangrove	7
Intertidal Mudflat	8
Sub-Total:	**151**
Medium Indicative Ecological Value	
Shrubby Grassland (including *Baeckea* Shrubland)	30
Fishpond/GeiWai	0 (aerial photographs)
Sandy Shore	4
Rocky Shore	5
Cultivation	10
Sub-Total:	**49**
Overall Total:	**200**

3.4 REVIEW OF SURVEY RESULTS FOR SITE SELECTION

3.4.1 Selection of Survey Locations

In the previous habitat mapping exercise survey sites were chosen based on criteria that have been adopted for the present work, as follows:

(1) Lands Department (2001) Aerial Photographs - DOP10000 (yr 2001 ver 1.1). Land Information Centre, Survey and Mapping Offoce, Lands Department, Hong Kong SAR Government 2001. Provided by courtesy of the SDU on 25 November 2002.

- sites that are uncertain with regard to the habitat type and/or boundary; and/or
- sites that have the potential to be upgraded/downgraded from the indicative ecological value assigned to that habitat type; and/or
- sites that lack updated information on ecological status; and/or
- sites that fall within the boundary of Sites of Special Scientific Interest (SSSIs); and/or
- sites close to the boundary of SSSIs, especially small SSSIs.

A total of 1,051 sub-sites were visited during the 140 ecological survey days of the previous mapping exercise. The percentage of area surveyed for each habitat type ranged from 0.1 to 96.4%. To identify the locations where surveys should be undertaken, the actual area previously surveyed and the results obtained (that have been stored in the GIS database) have been reviewed to identify areas where surveys have not been conducted.

3.4.2 Review of Survey Results (Effort) of Previous Study

The results have been reviewed and the majority of the vegetation habitats, including Lowland Forest, Mixed Shrubland, Shrubby Grassland and Cultivation, surveyed only a small proportion of the total site area. Consequently, it was proposed to re-visit the site areas (boxes) to survey additional sub-sites where surveys have not been covered. For other habitats such as Natural Watercourse, Mangrove, Intertidal Mudflat, Sandy Shore and Rocky Shore the mapped habitats within the site areas have already been adequately surveyed during the previous Study and therefore only new locations were proposed. Based on the ecological status of the habitat, information gaps identified (refer to *Table 2.1*) and recommendations of the previous Study, allocation of additional survey effort to other habitats such as Montane Forest, Seagrass Bed, Grassland, Modified Watercourse, Artificial Rocky/Hard Shoreline, Golf Course/Urban Park, Bare Rock or Soil, and Quarry were considered not necessary.

4 SURVEY METHODOLOGY

4.1 INTRODUCTION

The present Study has been executed in accordance with the specifications delineated in Attachment 1 of the Tender Brief (Ref. DAU/11/2002). The methodology employed is based on that used previously by the SUSDEV 21 Environmental Baseline Survey(1.). The previous Study involved delineating terrestrial and coastal habitats on the basis of satellite imagery and aerial photographs, and assigning an ecological value to those habitats through field surveys and use of existing information. The scope of the survey encompassed all terrestrial habitats including those above the low tide mark. The map and mapping system were produced with reference to the latest available satellite images and aerial photographs of Hong Kong at the time of the previous Study (ie October – December 1998 for satellite images and January 1997 for aerial photographs), available results of the Biodiversity Survey(2), and dedicated field investigations conducted by the Study Team.

4.2 REVIEW OF PREVIOUS SURVEY METHODOLOGY

As described in *Topic Report 2*(3) of the previous Study, field surveys were proposed to be undertaken to fulfil two objectives: habitat verification (general and supplemental); and ecological value assessment. The general approach of the surveys adopted by the previous Study to achieve the above objectives includes the following:

Habitat Verification (HV) Surveys: To fulfil the purpose of habitat verification, the sites selected for each habitat category have been groundtruthed by qualified ecologists. Groundtruthing included verifying the habitat location, type and, wherever possible, boundary (some habitats, eg forests, may cover a huge area or offer poor accessibility which may make boundary verification impossible). The methodology for groundtruthing included drawing sketch diagrams of the site, taking photographs, and checking the locations (and boundaries) against the base map using a GPS. In order to assist the surveyor to locate his/her position in the field, each surveyor was equipped with a Pocket Computer (PC) linked to GPS units (although it is acknowledged that GPS may be of limited use when surveying under canopy) and installed with a reasonably high resolution base map with adequate locational indicators (eg footpaths, streams, buildings, police stations). However, even with these aids, mapping the boundary of a shrubland/forest habitat would rely heavily on the judgement of the experienced surveyors who would map as accurately as possible given the

(1) ERM-Hong Kong, Ltd (2000) *Op cit.*

(2) Department Ecology & Biodiversity (2000) Biodiversity Database CD-ROM version 1.

(3) ERM-Hong Kong, Ltd (1999) *Op cit.*

conditions and the effort limitations (ie time available). Details of the Pocket PCs are discussed below.

Ecological Value Assessment (EVA) Surveys: Field surveys using habitat-specific methodology have been conducted, and supplemented with information on dominant species and species of conservation importance observed during the field survey, to validate the indicative ecological value of certain habitat categories. The information collected have been used to provide an initial assessment of the suitability of the habitat for rare, endangered or otherwise special species and the likelihood that these species may be present. The data have been be used to justify the validity of ecological value against the criteria delineated in *Topic Report 2*(1) of the previous Study and *Topic Report*(2) of this Study (also see *Section 2.2.2* of this Report) and upgrade or downgrade the indicative value, when necessary.

In addition to the general approach described above, habitat-specific methodologies were also devised for the previous Study. The general approach of the surveys and methodologies specific to each habitat type was identified in *Topic Report 2* of the previous Study and *Topic Report* of this Study.

4.3 USE OF POCKET COMPUTER (PC) FOR FIELD SURVEY WORK

It is important during the field survey phase of the project that information be collected in a consistent, comprehensive and accurate fashion. *Clause 4.1.3* of the Tender Brief (Task 3: Field Surveys; see *Figure 1.1a*) requires the specialists should "mark the field observations onto a map and translate them into GIS format". Paper based surveys are often inefficient for a variety of reasons including incomplete data capture, inconsistent nomenclature when many survey teams are involved and mistakes made while transcribing data during entry at base. Inputting the field data directly into a computer would eliminate these errors. Current technology would allow the loading of a digital proforma for collection of ecological data, base maps of the existing Habitat Map and a ' light' version of GIS software (such as ESRI' s ArcPAD) onto a hand held Windows CE PC' s. This would ensure validation of the data at point of collection, eliminate double entry and ensure completeness. The other advantage of these units is that they can be linked to GPS units quite easily, which greatly assists surveyors in locating where they are in the field. Pocket PCs were therefore used to assist in field surveys for this Study. *Figure 4.3a* shows an example of how such a system was used in the field surveys.

Topographic data, aerial photos and the existing habitat map were "clipped" into manageable data packets for upload onto the Pocket PCs and use by the field surveyors.

(1) ERM-Hong Kong, Ltd (1999) *Op cit.*

(2) ERM-Hong Kong, Ltd (2002) *Op cit.*

4.4 OPTIMAL SURVEY PERIODS FOR HABITATS

Field surveys have been conducted by the Field Survey Team which is a team of qualified terrestrial and coastal ecologists. Wherever possible, surveys were conducted during the period (if known) when the ecological value of the habitat is most apparent and thus most accurately recorded. In addition, surveys of individual habitat types would be scheduled during the same period and conducted, where possible, by the same ecology specialist in order to allow direct compatibility of results within a habitat type and individual consistency among surveyors.

The optimal survey periods for all habitat types are depicted in *Figure 4.4a*. It is desirable to conduct surveys on a habitat when its resources are more likely to be observed. However, due to the time constraints for this Study, ie conduct of field surveys is limited to a certain period of a year (November 2002 – March 2003), some of the habitat categories (eg Freshwater/Brackish Wetland, Natural Watercourse, Intertidal Mudflat, Shrubby Grassland and Cultivation) have to be inevitably surveyed outside the respective optimal survey periods.

4.5 HABITAT-SPECIFIC ECOLOGICAL FIELD SURVEY METHODOLOGY

4.5.1 *Fung Shui Forest*

Objective: Habitat Verification (HV)

The coordinates of the surveyed site were checked against the existing SUSDEV 21 habitat map using a hand held Window' s CE Pocket Computer with GIS software linked to Global Positioning System (GPS) unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the fung shui forest in the map was marked and amended *in situ*. Photographs were also taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of a fung shui forest was assessed based on the following aspects:

- naturalness (1) of the habitat;
- size (2) of the habitat;
- structural complexity (ie openness of the canopy, canopy stratification and abundance of the under-storey vegetation);

(1) Based on the guidance contained in the Environmental Impact Assessment Technical Memorandum (EIAO-TM) for ecological impact, a truly natural habitat (ie not modified by man) is usually highly valued while a less modified habitat will be rated higher than a highly modified one.

(2) Based on the EIAO-TM, larger area of habitat(s) shall be more valuable than smaller ones.

- number and abundance of faunal and floral species groups observed; presence of "rare" (1) species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (2) (if any).

The number of animal and plant species groups encountered along a walking transect (3) was recorded, with particular attention directed to the presence of "rare" species. Wherever possible, abundance of individually encountered species groups was graded as "dominant" (occurs in > 80% of the defined area), "abundant" (occurs in 60 - 80% of the defined area), "frequent" (occurs in 40 - 60% of the defined area), "occasional" (occurs in 20 - 40% of the defined area) or "scarce" (occurs in < 20% of the defined area) based on the abundance scale defined by Spellerberg (1981) (4) and Magurran (1988) (5). The presence of recognised ecologically important habitats in close proximity to the survey area which contains similar habitats was also noted as this may increase the opportunity for the study area to support fauna of ecological importance. The information collected was used to evaluate the ecological value of the surveyed forests against the set criteria. Since there is no particular optimal survey period for the habitat (see *Figure 4.4a*), field surveys can be conducted at any time within the survey period. Surveys were undertaken during December 2002. The survey efforts, including the time allocation at individual selected sites, and the survey objectives are presented in *Table 4.1*, and the survey locations are presented in *Figure 4.5a*.

Table 4.1 Allocation of Survey Effort for Fung Shui Forest

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	0	5	HV; EVA
Sai Kung	0	3	HV; EVA
Lantau Island	0	1	HV; EVA

(1) As agreed in the previous study the term "rare" has been applied when species are endemic, locally rare, or regionally rare if there is no evidence of the species occurring outside Hong Kong, or in many places in Hong Kong or in many localities in the region, respectively.

(2) Degree of disturbance and damage of a habitat was recorded relative to the existing condition of the area (ie based on the ambient situation noted by the surveyor during the site visit) instead of the situation in the past.

(3) A "walking transect" refers to the path a surveyor walks when he/she was conducting surveys on the habitat. Along the transect, the surveyor took notes on whatever organisms he/she encountered and any other features of ecological interest. Although the survey path would be planned before arriving at the site, the walking transect may be restricted by unforeseen inaccessibility, and thus may change accordingly.

(4) Spellerberg IF (1981) Ecological Evaluation for Conservation, Studies in Biology No 133, Edward Arnold (Publishers) Ltd.

(5) Magurran AE (1998) Ecological Diversity and its Measurement. Croom Helm Ltd, London.

4.5.2 Lowland Forest

Objective: Habitat Verification (HV)

Groundtruthing of the habitat was achieved by checking the habitat type, location and boundary against the existing SUSDEV habitat map using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the lowland forest in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of the habitat was evaluated based on the information collected during the field surveys. This information included the following components:

- naturalness of the habitat;
- size of the habitat;
- structural complexity (ie openness of the canopy, canopy stratification and status of the under-storey vegetation);
- number and abundance of faunal and floral species groups;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

The number of fauna and plant species groups encountered along a walking transect was recorded, with particular attention being directed to the presence of "rare" species. Wherever possible, abundance of individual encountered species groups was graded as either "dominant", "abundant", "frequent", "occasional" or "scarce" depending on their relative abundance. The presence of recognised ecologically important habitats in close proximity to the survey area which contains like habitats within it was also noted as this may increase the opportunity for the study area to support fauna which are of ecological importance.

Similar to other forest habitat types, lowland forest has no evident seasonal trend in ecological resources (see *Figure 4.4a*) and, therefore, this habitat can be surveyed at any time during the survey period. Surveys started in late December 2002 and were completed by end March 2003. *Table 4.2* presents the survey effort allocation for the lowland forest habitat category, and *Figure 4.5b* presents the survey locations.

Table 4.2 Allocation of Survey Effort for Lowland Forest

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	3	5	HV; EVA
North-west New Territories	3	0	HV; EVA
Central New Territories	4	5	HV; EVA
Sai Kung	3	7	HV; EVA
Lantau Island	2	3	HV; EVA
Hong Kong Island	3	2	HV; EVA
Outlying Islands	0	1	HV; EVA

4.5.3 Mixed Shrubland

Objective: Habitat Verification (HV)

The habitat type, location and boundary of an identified mixed shrubland habitat was checked against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the mixed shrubland in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of the habitat was evaluated based on the information collected during the field surveys. The information included the following aspects:

- naturalness of the habitat;
- size of the habitat;
- structural complexity (ie openness of the habitat and habitat heterogeneity);
- number and abundance of faunal and floral species groups;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

The number of animal and plant species groups encountered along a walking transect was recorded, with particular attention being directed to the presence of "rare" species. Wherever possible, abundance of individual encountered species groups was graded as either "dominant", "abundant", "frequent", "occasional" or "scarce" depending on their relative abundance. The presence of recognised ecologically important habitats in close proximity to the survey area which contains like habitats within it was also noted as this may increase

the opportunity for the study area to support animals which are of ecological importance. Since the habitat shows no optimal survey periods (see *Figure 4.4a*), mixed shrubland surveys can be conducted at any time during the survey period. Field surveys began in late December 2002 and were completed in mid March 2003. The survey effort allocation for the mixed shrubland habitat category is presented below (*Table 4.3*) and the survey locations are presented in *Figure 4.5c.*

Table 4.3 Allocation of Survey Effort for Mixed Shrubland

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	3	0	HV; EVA
North-west New Territories	3	3	HV; EVA
Central New Territories	4	4	HV; EVA
Sai Kung	1	8	HV; EVA
Lantau Island	2	4	HV; EVA
Hong Kong Island	3	4	HV; EVA
Outlying Islands	1	1	HV; EVA

4.5.4 Freshwater/Brackish Wetlands

Objective: Habitat Verification (HV)

The habitat type, location and boundary of the visiting wetlands was checked against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the freshwater/brackish wetlands in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value assessment of a wetland was conducted based on compilation of information including:

- naturalness of the habitat;
- size of the habitat;
- type of wetland (eg marsh, reedbed, pool and pond) (1);
- salinity of the habitat waters;
- number and abundance of faunal and floral species groups encountered;
- presence of "rare" species (if any);

(1) The types of wetlands are taken from Dudgeon and Chan (1996) which include marsh, reedbed, pool and pond. Additional categories would be defined in the field, if necessary.

- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

Salinity of the wetland waters was measured using an optical refractometer to distinguish the brackish (> 10 ppt) (1) habitats from the freshwater ones as this may assist in characterising species assemblages and hence in determining the value of individual wetland sites. The number of animal and plant species groups encountered along a walking transect was recorded, with particular attention being directed to the presence of "rare" species. The presence of macroinvertebrates (eg dragonfly larvae), as well as vertebrates (eg fish and amphibian) was also noted through the use of a sampling net. Two sampling methodologies were adopted for macroinvertebrates depending on the nature of the wetland habitat under survey.

For wetlands which have been overgrown with vegetation and lacking extensive areas of open waters, surveyors looked for as many microhabitats as possible, including deep and shallow waters, shaded and unshaded areas, and in and around as many vegetation and substratum types as would be represented at the survey site. For wetlands where there are extensive areas of open waters (eg ponds), surveyors would pay more attention to areas close to the pond banks, in and around emergent and submerged vegetation, where animals tend to congregate. Individual abundances of the observed species groups were recorded by ranking them as "dominant", "abundant", "frequent", "occasional" or "scarce".

As indicated in *Figure 4.4a*, wetland surveys would preferably be carried out during the wet season when the habitat resources are best appraised. However, due to time constraints for this Study, surveys were conducted in February 2003 and March 2003 which is a sub-optimal period for wetland characterisation. Although the surveys were conducted outside the optional period, the surveyors focussed on habitat structure and the value of surrounding habitats to assign ecological value. This method is considered to be suitable and allows confidence in the survey results. The survey effort allocation for the wetland habitat category is presented in the following table (*Table 4.4*), and the survey locations are presented in *Figure 4.5d*.

Table 4.4 Allocation of Survey Effort for Freshwater/Brackish Wetland

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	0	8	HV; EVA
North-west New Territories	0	7	HV; EVA
Central New Territories	0	0	HV; EVA
Sai Kung	0	2	HV; EVA
Lantau Island	0	3	HV; EVA

(1) Dudgeon D and Chan EWC (1996) Ecological study of Freshwater Wetland Habitats in Hong Kong. Unpublished report for the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government.

4.5.5 Natural Watercourse

Objective: Habitat Verification (HV)

The habitat types and extent/boundary of the watercourses selected for surveying were uploaded onto a hand held Window' s CE PC with GIS software linked to GPS unit and checked against the information on the habitat map prepared for the previous Study. Field data were inputted directly into an electronic database during the survey, and the extent of the natural watercourse was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

A general description was made of the survey location. Characteristics surveyed included:

- naturalness of the habitat;
- size of the habitat;
- water quality (ie turbidity, water flow rate);
- nature of the substratum (ie coarseness of particles);
- number and abundance of floral and faunal species groups observed;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

Since a highly turbid, stagnant watercourse tends to have a lower ecological value, turbidity and water flow condition of the habitat were noted during the field visits. The nature of the substratum, ie whether it is composed of large pebbles or fine mud, was also described as it may affect the habitat value through a variation in its ability to provide shelter for stream organisms. The number of animal species groups encountered along a walking transect of the habitat was recorded with particular attention devoted to the presence of "rare" species. A sampling net was used to observe macroinvertebrates (eg dragonfly larvae) and vertebrates (eg fish). Animals living under rocks (eg mayfly nymph) were also recorded through active searching. Animals living in deep and shallow waters, and shaded and unshaded areas, as well as areas close to the river banks, and in and around emergent and submerged vegetation where animals tend to congregate were also noted. Wherever, possible, abundance of the species groups recorded was graded as "dominant", "abundant", "frequent", "occasional" or "scarce". In addition to the characteristics described above, degree of shade and presence of notable amount of detritus was also noted as they were regarded as important attributes of natural watercourse(1).

(1) Dudgeon D and Corlett R (1994) Hills and Streams: An Ecology of Hong Kong. Hong Kong University Press.

As indicated in *Figure 4.4a*, watercourse surveys would preferably be conducted during the wet season when the habitat resources (eg insect larvae, fish) are best appraised. However, due to time constraints for this Study, field surveys for Natural Watercourse were undertaken during the period between mid December 2002 and end March 2003 which is a sub-optimal survey period for characterisation of this habitat type. Although the surveys were conducted outside the optional period, the surveyors focussed on habitat structure and the value of surrounding habitats to assign ecological value. This method is considered to be suitable and allows confidence in the survey results. The survey effort allocation for the natural watercourse is presented in the following table (*Table 4.5*), and the survey locations are presented in *Figure 4.5e*.

Table 4.5 Allocation of Survey Effort far Natural Watercourse

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	3	3	HV; EVA
North-west New Territories	4	1	HV; EVA
Central New Territories	2	1	HV; EVA
Sai Kung	1	4	HV; EVA
Lantau Island	4	1	HV; EVA
Hong Kong Island	1	0	HV; EVA

4.5.6 Mangrove

Objective: Habitat Verification (HV)

"Spot-checking" of the habitat type and boundary of mangrove stands was achieved by checking the locations and boundaries of the stands against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the mangrove in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

During site visits, the following information was recorded:

- naturalness of the mangrove stand;
- size of the habitat;
- number and abundance of mangrove plant species groups;
- number and abundance of benthic macrofaunal species groups;
- presence of "rare" species (if any);
- presence of known ecologically important areas (eg fish spawning grounds) in its vicinity (if any); and
- degree of disturbance and damage (if any).

The distribution of the flora in each stand was measured by transect and quadrat analyses. Two transects were laid perpendicularly to the shoreline covering the extent of the mangrove community from land to sea. Along each transect, three quadrats (3m x 3m) were laid to record the type and abundance of the floral and macrofaunal species groups present, as well as the presence of plant seedlings. Special attention was also devoted to the presence of ecologically important floral and faunal species groups. Any on-going construction activities nearby or other disturbances, such as the discharge of pollutants into the habitat, were also recorded as these may cause degradation in the ecological status of the surveyed habitat. The information collected has been used to evaluate the ecological value of individual mangrove stands against the criteria delineated in *Section 2* of this Report.

As shown in *Figure 4.4a*, there is no seasonal restriction on the survey period for mangroves, therefore surveys can be conducted at any time when the tide is low enough to expose the habitat. Surveys were undertaken during the period between mid February 2003 and early March 2003. Allocation of the survey effort over the mapped mangrove habitats and individual objectives for the selected survey locations are given in *Table 4.6*. The survey locations are presented in *Figure 4.5f.*

Table 4.6 Allocation of Survey Effort for Mangrove

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	2	0	HV; EVA
North-west New Territories	2	0	HV; EVA
Sai Kung	0	3	HV; EVA

4.5.7 Intertidal Mudflat

Objective: Habitat Verification (HV)

Groundtruthing of the habitat type and boundary of a mudflat was achieved by checking against the habitat map prepared for the previous Study wherever possible (ie some of the mudflats may be very soft in texture making surveying dangerous) by using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the intertidal mudflat in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

During field visits, a brief description of the mudflat habitat was compiled which encompassed:

- naturalness of the habitat;
- size of the habitat;

- number and abundance of macrofaunal species groups;
- presence of "rare" species (if any);
- presence of known ecologically important areas (eg seagrass beds) in its vicinity (if any); and,
- degree of disturbance and damage (if any).

The number of animal and plant species groups encountered along a walking transect was recorded, with particular attention being directed to the presence of "rare" species. Presence of other mobile fauna, such as crabs, fishes and mudskippers, was also recorded. Any signs of the presence of species of conservation importance (eg horseshoe crabs) were also noted. Wherever possible, abundance of individual species groups observed was defined as "dominant", "abundant", "frequent", "occasional" or "scarce" depending on their relative abundance. Any birds sighted as well as footmarks left by them (eg egrets) on the mudflat surface were also recorded. Any on-going construction activities nearby or other disturbances, such as the discharge of pollutants into the habitat, were also recorded as these may cause degradation in the ecological status of the survey habitat. The information collected has been used to validate the ecological value of individual habitats against the criteria set forth in *Section 2* of this Report.

The optimal survey period for Intertidal Mudflat was considered as from May to September when some important mudflat species, eg horseshoe crabs, appear to show seasonal variations in their abundance with highest abundances observed in summer(1).

However, due the time constraints for conducting field surveys for this Study, field surveys on intertidal mudflats were undertaken between mid February 2003 and early March 2003 which is a sub-optimal survey period for intertidal mudflat characterisation. Although the surveys were conducted outside the optional period, the surveyors focussed on habitat structure and the value of surrounding habitats to assign ecological value. This method is considered to be suitable and allows confidence in the survey results. The survey effort allocation for the intertidal mudflat habitat category is presented in the following table (*Table 4.7*), and the survey locations are presented in *Figure 4.5g*.

Table 4.7 Allocation of Survey Effort for Intertidal Mudflat

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	0	2	HV; EVA
North-west New Territories	0	1	HV; EVA
Sai Kung	0	4	HV; EVA
Lantau Island	0	1	HV; EVA

(1) Chiu HMC and Morton B (1999) The Biology, Distribution and Status of Horseshoe Crabs, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* (Arthropoda: Chelicerata): Recommendations for Conservation and Management. Final Report.

4.5.8 Shrubby Grassland (Including Baeckea Shrubland)

Objective: Habitat Verification (HV)

The habitat type, location and boundary of identified shrubby grassland habitat was checked against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the boundary of the shrubby grassland (including *Baeckea* shrubland) in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of the habitat was evaluated based on the information collected during the field surveys. The information compiled includes the following aspects:

- naturalness of the habitat;
- size of the habitat;
- structural complexity (ie openness of the habitat and habitat heterogeneity);
- number and abundance of faunal and floral species groups encountered;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

The number of animal and plant species groups encountered along a walking transect was recorded, with particular attention being directed to the presence of "rare" species. Wherever possible, abundance of species groups was graded as either "dominant", "abundant", "frequent", "occasional" or "scarce" depending on their relative abundance. The presence of recognised ecologically important habitats in close proximity to the survey area which contains like habitats within it was also noted as this may increase the opportunity for the study area to support animals which are of ecological importance.

The optimal survey periods for Shrubby Grassland and *Baeckea* Shrubland are between September and November and all year round, respectively (see *Figure 4.4a*). Surveys on shrubby grassland habitats (including *Baeckea* shrubland) were conducted during the period between late November 2002 and early March 2003. The allocation of survey effort for the habitat category is presented in *Table 4.8*. The survey locations are presented in *Figure 4.5h*.

Table 4.8 Allocation of Survey Effort for Shrubby Grassland (Including Baeckea Shrubland)

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	1	4	HV; EVA
North-west New Territories	4	2	HV; EVA
Central New Territories	1	4	HV; EVA
Sai Kung	2	4	HV; EVA
Lantau Island	3	1	HV; EVA
Hong Kong Island	2	2	HV; EVA

4.5.9 Sandy Shore

Objective: Habitat Verification (HV)

The habitat type and extent of a sandy shore was verified by checking against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the extent of the sandy shore in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of the habitat was evaluated based on the information collected during field surveys. A general description of the habitat has included the following components:

- naturalness of the habitat;
- size of the habitat;
- water quality (ie turbidity);
- nature of substratum;
- number and abundance of faunal and floral species groups encountered;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

As some sandy shores cover an extensive area, using the line transect approach alone, as proposed in *Topic Report 2* for the previous Study, would greatly limit the extent of area surveyed. A walking transect method (similar to intertidal mudflat) was employed to record the areal extent of the area and epifaunal species information. Infaunal species were recorded by taking core samples (size: 50 x 50 x 50 cm (1)) (5 - 15 replicates per site depending on

(1) As some sandy shores, particularly in the low shore region, are covered with numerous cobbles of various sizes, collecting a core sample with a depth of 50 cm would be difficult. However, the surveyor collected a sample with a reasonable depth in order to make the sample as representative as possible.

habitat size) randomly, covering high, mid and low shore regions. All the macrofaunal organisms within the core were recorded. As indicated in *Figure 4.4a*, sandy shore surveys can be conducted in any time of the year. Surveys were undertaken during February 2003. The survey programme for the sandy shore habitat type is delineated below (*Table 4.9*), and the survey locations are presented in *Figure 4.5i.*

Table 4.9 Allocation of Survey Effort for Sandy Shore

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-west New Territories	0	1	HV; EVA
Lantau Island	0	3	HV; EVA

4.5.10 Rocky Shore

Objective: Habitat Verification (HV)

"Spot-checking" of the habitat type and extent of a rocky shore was achieved by checking the location and extent of the shore against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the extent of the rocky shore in the map was marked and amended *in situ*. Photographs were taken to show the general condition of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of the habitat was evaluated based on the information collected during field surveys. A general description of the habitat has included the following components:

- naturalness of the habitat;
- size of the habitat;
- water quality (ie turbidity);
- nature of substratum;
- number and abundance of faunal and floral species groups encountered;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

The selected rocky shores were surveyed using a standard transect method. The data collected has provided information on the composition of the faunal and floral assemblages, and productivity of the habitats. At each site three 10 m wide horizontal (belt) transects were set up along the shore (no less than 50 m apart) and surveyed at three heights up the shore at 50 cm intervals perpendicular to the waterline starting at 1.0 m above Chart Datum. On each transect, 10 quadrats (0.5 x 0.5 m) were placed randomly to assess the distribution of flora and fauna. All animals found in each quadrat were

recorded. The percentage cover of algae (including encrusting, foliose and filamentous algae) within each quadrat was also recorded.

The changes in physical conditions between seasons in Hong Kong cause marked changes in the species composition of rocky shore communities. Several surveys on local rocky shores[1][2] have demonstrated that algal and faunal diversity and abundance are highest during the dry season and lowest during the wet season. On the basis of this, field surveys for the rocky shores have preferably been scheduled during the dry season months (see *Figure 4.4a*) in order to best establish and evaluate the ecological value of the survey shores. Surveys were undertaken during the period between early December 2003 and early April 2003. The survey programme for the rocky shore habitat type is delineated below (*Table 4.10*), and the survey locations are presented in *Figure 4.5j.*

Table 4.10 Allocation of Survey Effort for Rocky Shore

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
Sai Kung	0	1	HV; EVA
Lantau Island	0	1	HV; EVA
Outlying Islands	0	2	HV; EVA

4.5.11 Cultivation

Objective: Habitat Verification (HV)

Groundtruthing of cultivation habitat was achieved by checking the habitat type, location and boundary of the habitat against the habitat map prepared for the previous Study using a hand held Window' s CE PC with GIS software linked to GPS unit. Field data were inputted directly into an electronic database during the survey, and the extent of the habitat in the map was marked and amended *in situ*. Photographs were taken to show the general status of the habitat.

Objective: Ecological Value Assessment (EVA)

Ecological value of a cultivation area was assessed based on the following information collected during the field surveys:

- management status of the cultivation (ie active, abandoned, fallow, etc);
- size of the habitat;
- structural complexity (ie openness of the habitat and habitat heterogeneity);

(1) Kennish R, Williams GA and Lee SY (1996) Algal seasonality on an exposed rocky shore in Hong Kong and the dietary implications for the herbivorous crab *Grapsus albolineatus*.

(2) Kaehler S and Williams GA (1996) Distribution of algae on tropical rocky shores: spatial and temporal patterns of non-coralline encrusting algae in Hong Kong. Marine Biology 125: 177-187

- number and abundance of faunal and floral species groups encountered;
- presence of "rare" species (if any);
- presence of known ecologically important areas in its vicinity (if any); and
- degree of disturbance and damage (if any).

The number of animal and plant species groups encountered along a walking transect was recorded, with particular attention being directed to the presence of "rare" species. Wherever possible, abundance of individual encountered species groups was graded as either "dominant", "abundant", "frequent", "occasional" or "scarce" depending on their relative abundance. The presence of recognised ecologically important habitats in close proximity to the survey area which contains like habitats within it was also noted as this may increase the opportunity for the study area to support animals which are of ecological importance.

The optimal survey period for cultivation is during the wet season when organisms such as odonates and amphibians are best appraised (see *Figure 4.4a*). However, due to the time constraints for this Study, surveys for this habitat category were conducted during the period between late November 2003 and early March 2003 which is a sub-optimal survey period for cultivation characterisation. Although the surveys were conducted outside the optional period, the surveyors focussed an habitat structure and the values of surrounding habitats to assign ecological value. This method is considered to be suitable and allows confidence in the survey results. The following table (*Table 4.11)* presents the allocation of survey effort for cultivation habitats. The survey locations are presented in *Figure 4.5k*.

Table 4.11 Allocation of Survey Effort for Cultivation

Survey Areas	Previously Surveyed – to be surveyed (Days)	Proposed New Survey Sites (Days)	Survey Objective(s)
North-east New Territories	2	0	HV; EVA
North-west New Territories	4	0	HV; EVA
Sai Kung	1	0	HV; EVA
Lantau Island	1	0	HV; EVA

4.5.12 Fishpond/Gei Wai

Objective: Habitat Verification (HV)

Desktop "comprehensive-checking" of the habitat type and boundary of a fishpond/gei wai was achieved by checking the location and boundary of the habitat against the habitat map prepared for the previous Study and reviewing the latest aerial photographs(1) (provided by SDU on 25 November 2002).

(1) Lands Department (2001) *Op cit.*

Objective: Ecological Value Assessment (EVA)

The following criteria were considered for assessing the ecological value of a fishpond/gei wai during the desktop checking process:

- size of the habitat; and
- presence of known ecologically important areas in its vicinity (if any).

5 ECOLOGICAL FIELD SURVEYS

5.1 COORDINATION OF AND PLANNING OF FIELD SURVEYS

The proposal for field surveys (*Topic Report*) with details of survey effort allocation of 200 field survey days, site selection and survey methodology was accepted by the Government in November 2002. Ecological field surveys commenced on 29 November 2002 and the 200 survey days were completed on 5 April 2003.

Prior to actual commencement of field surveys, each surveyor familiarised himself/herself with the approved methodology and the equipment (eg field-computer for data entry, GPS) to be used for the survey. In order to ensure consistency of habitat judgement and conservation value assessment, two pre-trips were conducted at the beginning of the field survey period on 29 November 2002 and 3 December 2002. Habitats visited include the shrubby grassland in Tai Mo Shan Country Park (Site No. 23 of Shrubby Grassland), cultivation in Tai Lam Country Park (Site No. 4 of Cultivation), and the fung shui forest and natural watercourse in Kwu Tung (Site No. 6 of Fung Shui Forest and Site No. 6 of Natural Watercourse). This ensured that all of the Field Survey Team members were consistent in their judgement on habitat categorization with reference to the definitions defined for each habitat and, were familiarised with the usage of field equipment and the survey methodology adopted for the habitats.

5.2 CONDUCT OF FIELD SURVEYS

Surveys were conducted according to the approved methodology, which, as discussed above, is very similar to the methodology used for the previous Study. Surveyors collected information on the survey sites in accordance with the Proforma (*Annex A*).

During the field surveys, accuracy of habitat identifications and delineation of land cover boundaries were checked using GPS and conservation assessment undertaken according to the approved methodology.

For those areas which were found to have been mis-mapped and required re-classification, indicative ecological value of the re-identified habitat(s) was assigned to the re-classified area unless otherwise stated. If the ecological status was considered to be different from the indicative ecological value, an adjusted ecological value was given to the re-identified area.

For a correctly mapped habitat, ecological value was adjusted (ie upgraded or downgraded) from the indicative value if:

- the habitat was found to be substantially disturbed by human activities (thus requiring downgrading); and/or

- the habitat was found to support better (upgrade)/worse (downgrade) ecological characteristics than other areas of the same habitat type.

As mentioned in *Section 4.3*, field computers were used to assist the surveyors. Data collected were directly entered into the field computer.

Collection of Field Data by Pocket PC

Two main types of data have been collected in the field:

- Point data – This includes habitat type, weather, mapping accuracy, field photographs and ecological value information, eg species information, etc; and

- Polygonal data – Polygons have been drawn where areas of habitat have changed from that mapped in the previous habitat mapping exercise.

Point Data: Proformas were developed to assist surveyors in inputting the above data while in the field. These had validation mechanisms built in so that information could be recorded systematically. For example, species lists were pre-loaded so that correct names were used and spelling mistakes avoided.

Polygonal Data: Changes in habitat areas previously mapped have been mapped by surveyors as an ' edit mask' polygons layer. The polygons can be drawn directly over the habitat map base on the Pocket PC and can indicate to what type the habitat category should be changed.

In addition to the field computer, surveyors have also carried with them a hard copy site plan (where necessary) for which the surveyors can mark the field observations onto in case they might need to do so.

5.3 RESULTS OF ECOLOGICAL FIELD SURVEYS

The major findings on habitat mapping accuracy and ecological value ranking of individual habitat types that have been selected for field surveys are discussed in the following sections. Locations of the surveyed sub-sites are presented in *Figures 5.3a–k*. The total area surveyed for each habitat category selected for field surveys in the present Study is shown in *Table 5.1*. The survey dates and number of sub-sites for each survey location of individual habitat types, the number and percentage of partially or wholly mis-identified sub-sites for each habitat category are provided in *Tables 5.2 – 5.21*. The field data collected have been analysed with reference to the results obtained in the previous Study.

The name of the sub-sites where habitat area has been re-classified, the re-classified habitat categories and the rationale for the re-classification are presented in *Annex B*. The percentage value of mis-identified habitat area provided for each sub-site in *Annex B* was estimated based on the surveyor' s *in situ* judgement in the field during the site visit. The location of sub-sites

where the pre-surveyed habitat boundary was found to be under-estimated and the type of the habitat(s) affected by the extension of the mapped habitat are also given in *Annex B*.

The location of sub-sites where ecological value has been re-adjusted and the reason for the re-adjustment are summarised in *Annex C*. The unique features identified during the field surveys are listed in *Annex D*. The change in the habitat area of surveyed habitat categories due to habitat re-classification and ecological value adjustment is provided in *Annex E*.

The sub-site locations where habitat has been re-classified and/or ecological value adjusted based on field surveys are shown in *Annex F*. The field data of each surveyed habitat collected from the field surveys are provided in Microsoft Access format (*Annex G*). In addition, the outstanding information gaps filled by the present Study and information gaps yet to be filled are also discussed in this Section and presented in *Table 2.1*.

Table 5.5.1 Total Area Surveyed for Each Habitat Category Selected for Field Surveys in this Study

Habitat Type	Total Area Surveyed (ha)	% Surveyed
Indicative Ecological Value – High		
Fung Shui Forest	93.5	N/A
Lowland Forest	1,113.0	6.1
Mixed Shrubland	867.1	5.3
Freshwater/Brackish Wetland	229.8	19.6
Natural Watercourse	34.1	4.2
Mangrove	103.5	36.8
Intertidal Mudflat	43.0	2.6
Indicative Ecological Value – Medium		
Shrubby Grassland (including *Baeckea* Shrubland)	319.8	2.2
Sandy Shore[e]	14.7	9.8
Rocky Shore[e]	33.9	4.7
Cultivation	219.2	5.1

Note:

The majority of Fung Shui Forest was initially represented as dot locations on the habitat map and therefore was not applicable for spatial calculation.

e: The habitat (or majority of it) was mapped as a linear component, the total "area" surveyed for the habitat is represented by the length (km) of the habitat.

5.3.1 Fung Shui Forest

Previous Study

Based on the existing database from the previous Study, fung shui forests were mapped based on existing information (with grid coordinates) from Chu(1) who has recorded point locations of 115 identified fung shui forest and

(1) Chu KWH (1998) Conservation of Terrestrial Biodiversity in Hong Kong. MPhil Thesis, The University of Hong Kong.

boundaries for 17 of these habitats (see *Figures 4.5a* and *5.3a*). Field surveys of the previous Study were conducted on 25 patches of fung shui forests (which had their locations mapped but the boundaries were unknown). All these forest habitats were found to be correct with regard to their location identified on the habitat map(2).

Present Study

A total of 9 days of survey effort have been assigned to this habitat category under this Study and surveys were completed during the period from 3 December 2002 to 24 December 2002 (*Table 5.2*).

Table 5.2 Survey Schedule for Fung Shui Forest

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Ma On Shan Country Park	4	12 December 2002
2	Pak Kok Chi	3	22 December 2002
3	Lai Chi Wo	4	23 December 2002
4	Kuk Po	6	14 December 2002
5	Pak Fu Shek	4	20 December 2002
6	Kwu Tung	3	3 December 2002
7	Ng Fai Tin	3	13 December 2002
8	Tong Fuk Miu Wan	2	24 December 2002
9	Shek Au Shan	4	19 December 2002
	Total:	33	

Habitat Mapping: A total of 33 sub-sites were surveyed for Fung Shui Forest and their locations are shown on *Figure 5.3a*. The majority of the sub-sites surveyed (31 out of 33) were mapped correctly with only one sub-site (Site 6c) being re-classified as Lowland Forest and 20% of another sub-site (Site 8a) re-identified as Mixed Shrubland. The ecological value of the re-identified habitat is high (*Table 5.3* and *Table B1* of *Annex B*). The area re-classified into Lowland Forest and Mixed Shrubland is provided in *Table E1a* of *Annex E*. The habitat type and area re-identified as Fung Shui Forest is presented in *Table E1b* of *Annex E*. The sub-site locations of Fung Shui Forest where re-classification of habitat types had occurred are shown in *Figure F1* of *Annex F*.

Table 5.3 Number and Percentage of Fnug Shui Forest Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 33)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Lowland Forest	1	3.0
Mixed Shrubland	1	3.0
Total:	2	6.0

Ecological Value Assessment: In general, the sub-sites are well preserved forests of 6 to 30 m tall with many mature native trees. Moreover, rare species such as *Machilus kwangtungensis* and *Xylosma longifolium* were recorded in

(2) ERM-Hong Kong, Ltd (2000) *Op cit.*

Kwu Tung (eg Sites 6a and 6b) and Kuk Po (eg Sites 4a and 4b). Other rare species such as *Elaeocarpus dubius*, *Euonymus kwangtungensis*, *Ficus langkokensis* and *Litsea greenmaniana* were encountered in Ma On Shan Country Park (eg Site 1b). These species are considered to be restricted to lowland forests and fung shui forests.

A small proportion of sub-sites were found to be disturbed by urban development and resulted in discontinuous canopy and overgrowth of *Mikania micrantha* and *Ipomoea spp*. Trunk cutting of mature *Cinnamomum camphora* was also recorded in one of the survey sites, ie Kwu Tung (Site 6b). The ecological value of the surveyed habitat sub-sites was considered as high and no downgrading of ecological ranking was considered necessary.

Information Gaps

The 17 fung shui forest sites (with known boundaries) from Chu(1) together with the 25 patches of habitats surveyed under the previous Study and the 33 patches under the present Study have resulted in a total of 75 locations of fung shui forests mapped with determined boundaries. There are 40 (115 - 75) point locations of fung shui forests which remain uncertain in their areal extent (*Table 2.1*).

5.3.2 Lowland Forest

Previous Study

The field surveys conducted for the previous Study have covered a total of 15 sites of lowland forests with 106 sub-sites (total surveyed area 1,326 ha). The locations of these surveyed sub-sites are presented in *Figures 4.5b* and *5.3b*. About 50% of the sub-sites (in terms of number) were mapped correctly as Lowland Forest. The other sub-sites were identified with varying degrees of accuracy and were re-classified as either Mixed Shrubland, Plantation or Plantation/Mixed Forest, Shrubby Grassland, *Baeckea* Shrubland, Cultivation, Bare rock or Soil or Other(1).

Present Study

The present Study has assigned a total of 41 days of survey effort to Lowland Forest to verify the habitat' s mapping accuracy and ecological value. Field surveys for this habitat category commenced on 28 December 2002 and were completed on 24 March 2003 (*Table 5.4*).

(1) Chu (1998) *Op cit.*

(1) ERM-Hong Kong, Ltd (2000) *Op cit.*

Table 5.4 Survey Schedule for Lowland Forest

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Tai Lam Country Park	7	11 February 2003
2	Chi Ma Wan Peninsula	5	24 March 2003
3	Lantau South Country Park	7	19 March 2003
4	Ngong Ping	6	12 February 2003
5	Tung Lung Chau	7	22 February 2003
6	Lin Fa Shan	9	25 February 2003
7	Tai Tam Country Park	6	3 January 2003
8	Shek O Country Park	10	26 February 2003
9	Aberdeen Country Park	5	6 January 2003
10	Lung Fu Shan Country Park	13	19 February 2003
11	Por Kai Shan	7	3 March 2003
12	Lung Ha Wan	7	13 January 2003
13	Fei Ngo Shan	7	28 December 2002
14	Kam Shan Country Park	8	6 March 2003
15	Beacon Hill	7	21 March 2003
16	Pak Sha Wan	6	17 January 2003
17	Tai Mo Shan Country Park	8	15 February 2003
18	Yuen Tun Camp Site	7	14 February 2003
19	High Island Reservoir	7	17 March 2003
20	Ma On Shan Country Park	5	30 December 2002
21	Stanley	5	22 March 2003
22	Chuen Lung	7	4 February 2003
23	Pak Tam Chung	4	5 January 2003
24	Castle Peak	5	28 February 2003
25	Shing Mun Country Park	6	9 February 2003
26	Tai Mo Shan Country Park	6	24 February 2003
27	Tai Mong Tsai	6	4 January 2003
28	Kap Lung	11	17 February 2003
29	Ma On Shan Tsuen	6	31 December 2002
30	Tai Po Kau Nature Reserve	12	18 February 2003
31	Hoi Ha Wan Marine Park	8	21 February 2003
32	Shek Kong	6	8 February 2003
33	Tin Shui Wai	6	16 February 2003
34	Lam Tsuen Country Park	8	27 February 2003
35	Pat Sin Leng	9	8 March 2003
36	Kai Kung Leng	3	20 February 2003
37	Cloudy Hill	7	23 February 2003
38	Plover Cove Country Park	3	6 February 2003
39	Pat Sin Leng Country Park	6	10 February 2003
40	Robin's Nest	5	13 February 2003
41	Sai Kung East Country Park	5	12 January 2003
		Total: 278	

Habitat Mapping: A total of 41 survey locations (with 278 sub-sites) were surveyed within the survey period. The location of the sub-sites is presented on *Figure 5.3b*. The mapping accuracy of most of the sub-sites is moderate

with a number of the habitat areas being re-classified as Fung Shui Forest, Mixed Shrubland, Plantation or Plantation/Mixed Forest, Shrubby Grassland, Cultivation and Other (*Table 5.5*) .

About 10 – 20% of seven lowland forest sub-sites, including Sites 13a, 16b, 16d, 20e, 22g, 25c and 27d, have been re-identified as Fung Shui Forest as these habitats appeared to be natural forests of over 60 years and dominated by native species and they were found to be located beyond villages with temple(s) and/or earth shrine(s) in front of the forest (*Table 5.5* and *Table B2a* of *Annex B*).

The majority of the mis-identified sub-sites (51 out of 104) were found to be either fully or partially occupied by mixed shrubland and were thus re-classified into the "Mixed Shrubland" category. A total of 37 sub-sites (about 13.3%), including Tai Lam Country Park (Sites 1a, 1c, 1d, 1f and 1g), Ngong Ping (Sites 4e and 4f), Kam Shan Country Park (Site 14a), Tai Mo Shan Country Park (Sites 17a, 17b, 17d and 17f), Yuen Tun Camp Site (Sites 18a, 18b, 18c, 18e, 18f and 18g), Chuen Lung (Sites 22a, 22c and 22f), Castle Peak (Sites 24b and 24e), Tai Mong Tsai (Site 27a), Kap Lung (Sites 28d, 28e, 28f, 28g, 28h and 28i), Ma On Shan Tsuen (Site 29a), Hoi Ha Wan Marine Park (Sites 31f, 31g and 31h), Lam Tsuen Country Park (Site 34h) and Kai Kung Leng (Site 36c), have been re-classified as Plantation or Plantation/Mixed Forest.

Six sub-sites of the lowland forest habitats (ie Sites 5b, 17c, 24a, 33a, 33b and 38b) are actually occupied by orchards and planted with fruit trees (eg *Dimocarpus longan* and *Litchi chinensis*). The habitat areas were re-classified as Cultivation and an ecological value of medium was assigned. One of the sub-sites (Site 25e) has 50% of the area re-mapped as Shrubby Grassland and an ecological value of medium was given to the re-identified habitat.

Mis-identification of lowland forests as plantations, mixed shrubland, fung shui forests is possibly due to the proximity of the spectral properties of these vegetation habitats and their tendency to intermingle with each other.

Some of the lowland forest habitats surveyed were seen to be under construction or have been developed into urban areas (eg Sites 12e and 33e) and therefore the habitat area was re-classified as Other. The re-identified developed area might have been changed from lowland forest since the last Study when the area was mapped as Lowland Forest using satellite imagery and aerial photographs.

The size of the originally mapped lowland forest areas re-classified to other habitat types is presented in *Table E2a* of *Annex E*.

Table 5.5 Number and Percentage of Lowland Forest Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 278)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Fung Shui Forest	7	2.5
Mixed Shrubland	51	18.3
Plantation or Plantation/Mixed Forest	37	13.3
Shrubby Grassland	1	0.4
Cultivation	6	2.2
Other	2	0.7
	Total: 104	37.4

A total of 17 sub-sites surveyed for Lowland Forest were under-estimated in terms of their areal extension (*Table B2b* of *Annex B*). The actual boundary of the extended habitat area was re-identified on the habitat map and a high ecological value was assigned. Six habitat types, including Mixed Shrubland, Natural Watercourse, Shrubby Grassland, Cultivation, Grassland and Other, were affected by the extension of these lowland forest sub-sites and their respective affected areas are listed in *Table E2a* of *Annex E.*

Ecological Value Assessment: Most of the lowland forests surveyed are located on islands (eg Site 5 Tung Lung Chau) or along coastlines (eg Site 6 Lin Fa Shan on Pui O, Site 10 Lung Fu Shan Country Park on Mount Davis, and Site 11 Por Kai Shan on Wong Lung Hang). Heights of the plant species of these survey sites were found to be restricted to shrubland levels possibly due to exposure to strong wind. The majority of the lowland forests visited show high species diversity with little human distance and relatively intact, especially those located near freshwater streams (eg Sites 11e and 26f) and in valleys (eg Sites 28a and 34a). Ecological value of these habitats remains high and no downgrade of ecological value was considered necessary.

A few of the re-classified fung shui forests (eg Sites 13a and 16b) were seen to have received moderate level of disturbance (eg trampling and wood cutting) from the nearby villagers. Ecological value of these re-identified fung shui forests was considered as high.

Some of the re-identified mixed shrubland habitats appear to have been disturbed by hill fire and urban development. Most of the re-identified mixed shrubland habitats are rich in native species and an ecological value of high was assigned.

The re-classified plantation habitats are largely dominated by exotic woody species (eg *Acacia confusa, Acacia mangium, Lophostemon conferta*) with undergrowth of native species, such as *Litsea glutinosa, Schefflera octophylla* and *Psychotria rubra*. These plantations show a relatively lower species diversity than lowland forest and an ecological value of medium was assigned to these habitats. The disturbances recorded in these re-classified plantations are mainly trampling by hikers (eg Site 26 Shing Mun Reservoir and Site 1 Tai Lam Country Park).

A total of 13 sub-sites of lowland forests (about 4.7% of total lowland forest sub-sites) were identified as possessing unique features. Lantau North Country Park (Sites 4a and 4b), Lin Fa Shan (Site 6b), Shek O Country Park (Sites 8b, 8c and 8d), Lung Fu Shan Country Park (Sites 10e and 10h), Por Kai Shan (Sites 11f and 11g), Tai Po Kau Nature Reserve (Sites 30k and 30l) and Fanling (Site 34e). The habitats are truly natural forests with highly stratified canopy and often dominated by native species. Climax plant species such as *Machilus chekiangensis, Omosia semicastrata, Castanopsis fissa* and *Cinnamomum parthenoxylon* were commonly recorded in these habitat areas. In addition, these forests supported a wide range of wildlife (eg avifauna). These habitats were considered to be pristine lowland forests in Hong Kong and an "*" was assigned to the habitats (*Annex D*).

The sub-site locations of Lowland Forest with habitat re-identification and/or ecological value adjustment are provided in *Figure F2* of *Annex F*.

Information Gaps

A total of 1,113 ha of lowland forest were surveyed in the present Study and 1,326 ha in the previous Study (*Table 5.1*). There are still about 15,894 ha of lowland forest identified on the habitat map left unsurveyed and their habitat type and ecological value remain to be field verified (*Table 2.1*).

5.3.3 Mixed Shrubland

Previous Study

The previous Study has surveyed a total of 17 sites (155 sub-sites) of mixed shrubland. Of the 155 shrubland patches surveyed, over 40% of them were 100% correct in mapping accuracy. The majority of the mis-classified habitats were lowland forest while some areas should have been mapped as Plantation or Plantation/Mixed Forest(1).

Present Study

The present Study has budgeted a total of 41 days of survey effort to Mixed Shrubland. The Field Survey Team commenced surveys on this habitat on 4 December 2002 and completed on 13 March 2003 (*Table 5.6*).

Table 5.6 Survey Schedule for Mixed Shrubland

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Lung Kwu Sheung Tan	5	5 February 2003
2	Ha Tsuen	3	11 January 2003
3	Tai Tong	9	22 December 2003
4	Tai Mo Shan	7	23 December 2003
5	Fanling	5	24 December 2003
6	Shing Mun Reservoir	7	25 December 2003

(1) ERM-Hong Kong, Ltd (2000) *Op cit.*

Site No.	Survey Location	Number of Sub-sites	Survey Date
7	Beacon Hill	8	26 December 2003
8	Pat Sin Leng Country Park	5	6 February 2003
9	Ma On Shan	10	11 March 2003
10	Fei Ngo Shan	9	27 December 2003
11	Tung Lung Chau	4	4 December 2003
12	Shek O	8	2 January 2003
13	Tai Tam Country Park	11	28 December 2003
14	Mui Wo	7	8 March 2003
15	Ngong Ping	6	29 December 2003
16	Pak Tai To Yan	7	2 February 2003
17	Ma Hang Shan	9	30 December 2002
18	Marina Cove	7	2 March 2003
19	Chi Ma Wan Peninsula	7	7 March 2003
20	Tai Lam Chung Reservoir	10	1 March2003
21	Plover Cove	6	13 March 2003
22	Luk Chau Shan	6	8 February 2003
23	Ko Lau Wan	6	9 March 2003
24	Aberdeen Country Park	8	12 February 2003
25	Siu Sai Wan	8	31 December 2003
26	Tai Tung Shan	5	1 January 2003
27	Lung Fu Shan Country Park	8	10 March 2003
28	Siu Ma Shan	9	7 March 2003
29	Sham Chung	6	9 February 2003
30	Tung Chung	6	8 March 2003
31	Lung Ha Wan	7	4 February 2003
32	Tolo Harbour/Tai Po Kau	9	15 February 2003
33	Tai Mo Shan Country Park	6	5 March 2003
34	Kam Shan Country Park	11	11 February 2003
35	Ko Tong Hau	8	9 March 2003
36	Tai Lam Country Park	8	9 March 2003
37	Tai Long	9	6 March 2003
38	Sai Kung East Country Park	9	6 March 2003
39	Tuen Mun	8	10 February 2003
40	Breakthrough Youth Holiday Village	11	13 February 2003
41	Shek Mun Shan	10	7 March 2003
		Total: 309	

Habitat Mapping: A total of 41 mixed shrubland habitats (309 sub-sites) were surveyed during the survey period and the locations of the sub-sites are presented on *Figure 5.3c.* The majority of the mixed shrublands surveyed (239 out of 309) were correctly identified and no re-classification is required.

A total of 28 mixed shrubland habitats (about 9.1% of total sub-sites surveyed for Mixed Shrubland) were actually lowland forests (partially or wholly) as the areas were mainly occupied by natural woody plants. Five sub-sites (Sites 14a, 14b, 14c, 14g and 19g) were re-classified as Fung Shui Forest as the habitat area was occupied by a natural forest which was found to be located behind

villages and with a temple and/or a land shrine nearby. Twenty-one sub-sites (about 6.8% of total mixed shrubland sub-sites) visited were found to be occupied (partially or wholly) by plantations and were thus re-classified as Plantation or Plantation/Mixed Forest and an indicative ecological value of medium was given (*Table 5.7* and *Table B3* of *Annex B*).

One of the sub-sites in Chi Ma Wan Peninsula (Site 19a) located close to the Pui O Marsh was actually a wetland and was thus re-classified into Freshwater/Brackish Wetland. There were six patches of shrubby grassland (Sites 4g, 5c, 6b, 21d, 23f and 39e) and two patches of grassland (Sites 5a and 10c) found to be partially or entirely mis-identified as mixed shrubland and were thus re-classified to the respective habitat categories and indicative ecological values of medium (for shrubby grassland) and low (for grassland) were assigned (*Table 5.7* and *Table B3* of *Annex B*).

About 1.9% (6 out of 309) of the sub-sites (including Sites 4f, 14d, 16a, 22d, 39c and 39g) had been mis-identified and was re-classified as Cultivation and an indicative ecological value of medium was assigned (*Table 5.7* and *Table B3* of *Annex B*). Mis-classification of fung shui forests, lowland forests, plantations, wetlands and shrubby grasslands can probably be attributed to the similarity in the spectral properties of these vegetation habitats to mixed shrubland.

About 5% of one of the sub-sites in Tai Tong (Site 3a) surveyed has been modified into a cemented slope and was thus re-identified under the "Other" category and an indicative ecological value of negligible was given (*Table 5.7* and *Table B3* of *Annex B*).

The size of individual habitat areas re-identified from Mixed Shrubland is shown in *Table E3a* of *Annex E*.

Table 5.7 Number and Percentage of Mixed Shrubland Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 309)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Fung Shui Forest	5	1.6
Lowland Forest	28	9.1
Freshwater/Brackish Wetland	1	0.3
Plantation or Plantation/Mixed Forest	21	6.8
Shrubby Grassland	6	1.9
Cultivation	6	1.9
Grassland	2	0.6
Other	1	0.3
Total:	70	22.7

Ecological Value Assessment: Many of the mixed shrubland encountered are small patches and located within country parks (eg Site 35 Ko Tong Hau in Sai Kung Country Park, Site 26 Tai Tung Shan in North Lantau Island) and remote areas (eg Site 29 Sham Chung and Site 16 Pak Tai To Yan) where they received little disturbance from urban development. Only a small proportion of habitat (eg Site 2 Sheung Pak Lei, Site 39 Tuen Mun and Site 33 Tai Mo Shan

Country Park) was recorded as disturbed by urban development and trampling by walkers.

Most of the mixed shrubland habitats surveyed were well-preserved and subject to little human disturbance and an ecological value of high was assigned. A total of 13 correctly mapped mixed shrubland sub-sites (ie about 4.2% of total mixed shrubland sub-sites) were downgraded in terms of their ecological value. These sub-sites, particularly those that are close to villages and residential areas (eg Fei Ngo Shan (Site 10c), Luk Chau Shan (Site 22d) and Ko Lau Wan (Site 23f)), were found to support comparatively low species diversity and received a high level of disturbance from nearby development, such as illegal dumping or hill fire. The ecological value of these areas was downgraded from high to medium (*Table C1* of *Annex C*). The total area of downgraded (to medium) mixed shrubland was 27.7 hectares (*Table E3b* of *Annex E*).

The mixed shrubland sub-sites where re-classification of habitat type and/or re-assessment of ecological value had taken place are shown in *Figure F3* of *Annex F*.

Information Gaps

A total of 309 sub-sites with a total of about 867 ha have been surveyed and verified in this Study. There are still about 13,302 hectares of mixed shrubland identified on the habitat map left unsurveyed and their habitat type and ecological value are yet to be confirmed.

5.3.4 Freshwater/ Brackish Wetland

Previous Study

Freshwater/Brackish Wetland was assigned 18 days of survey effort and a total of 249 patches (sub-sites) were visited in the previous Study. The habitat was found to be mapped with comparatively low accuracy with many of the mapped wetland sites were actually found to support other vegetation habitats, such as lowland forest, mixed shrubland, shrubby grassland, cultivation and grassland. A number of the suspected wetland sites were found to be of differing use, such as construction sites or developed area.

Present Study

A total of 20 days were assigned to the wetland habitat and a total of 104 sub-sites were visited during the survey period (*Table 5.8*). The locations of the sub-sites are shown in *Figure 5.3d*.

Table 5.8 Survey Schedule for Freshwater/Brackish Wetland

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Sha Tau Kok	5	24 March 2003
2	Tai Wan	8	27 February 2003
3	Hung Lung Hang	5	25 March 2003
4	Lung Yeuk Tau	5	28 March 2003
5	Ma Tso Lung	4	26 March 2003
6	San Tin	5	29 March 2003
7	Ngau Tam Mei	4	30 March 2003
8	Lam Tsuen Country Park	6	2 March 2003
9	Tai Hang	6	28 February 2003
10	Lau Fan Shan	5	26 March 2003
11	Ha Tsuen	6	31 March 2003
12	Ng Uk Tsuen	6	14 March 2003
13	Shap Pat Heung	5	1 March 2003
14	Kam Tin	6	19 March 2003
15	Pa Tau Kwu	4	11 February 2003
16	Mui Wo	4	28 March 2003
17	Chi Ma Wan	7	24 March 2003
18	Sai Kung	4	15 March 2003
19	Tai Chung Hau	4	16 March 2003
20	Ta Kwu Ling	5	25 March 2003
		Total: 104	

Habitat Mapping: The mapping accuracy of the wetland habitats surveyed was considered to be moderate. About 31.7% (33 out of 104) of the total sub-sites surveyed for wetland was found to be mapped 100% correct.

The majority of the mis-identified sub-sites (30 out of 71) have been re-classified into the "Cultivation" category. Some of these mis-mapped areas were found to be dried vegetated land and the plant species recorded were fairly homogeneous and of low species diversity (eg Sites 2e and 2f). These habitats were mainly colonised by some weedy species, such as *Mikania* sp. Some of them were actually abandoned farmland and were thus re-identified as Cultivation and a medium ecological value was assigned (eg Sites 4d, 4e, 6c and 6d) (*Table 5.9* and *Table B4a* of *Annex B*). However, five patches of the re-identified cultivation (Sites 8a, 11c, 12d, 13a and 13b) had their ecological value downgraded from medium to low as they were found to have been disturbed by urban development (*Table C2b* of *Annex C*).

There were two sub-sites, located in Chi Ma Wan (Site 17f) and Sai Kung (Site 18c), were actually occupied by natural lowland forests and were thus re-identified as Lowland Forest. The re-identified lowland forest in Chi Ma Wan (Site 17f) was given a high ecological value. However, the re-mapped lowland forest in Sai Kung (Site 18c) has been affected by the residential development nearby and the ecological value was downgraded from high to medium (*Table C2b* of *Annex C*).

Excluding those sub-sites that support more than one mis-mapped habitat types, a total of three patches of shrubby grassland (Sites 9d, 15b and 15c) and six patches of grassland (Sites 3a, 9b, 12b, 12c, 16c and 17a) were re-identified from wetlands during the field surveys. These re-mapped areas were re-classified into the respective habitat categories and indicative ecological values of medium (for shrubby grassland) and low (for grassland) were assigned correspondingly (*Table 5.9* and *Table B4a* of *Annex B*).

Three sub-sites were seen to support two mis-identified vegetation habitat types and these included Sites 15a (mixed shrubland and shrubby grassland), 17d (lowland forest and plantation) and 17g (lowland forest and grassland). These mis-mapped areas were re-classified to the respective habitat categories and corresponding indicative ecological values of high (for lowland forest and mixed shrubland), medium (for shrubby grassland and plantation) and low (for grassland) were assigned (*Table 5.9* and *Table B4a* of *Annex B*).

A total of 24 sub-sites were found to have been partially or wholly modified into developed areas and were thus re-classified into the "Other " category and an indicative ecological value of negligible was given. Some of them were found to have been filled and likely to become urban developed areas (eg Sites 6e and 7a) and some were seen to be occupied by concrete roads or car parks (eg Site 3e and 11a). Three sub-sites were recorded to support "Other" areas as well as mis-identified vegetation habitats and they are located in Tai Wan (Site 2h) and Chi Ma Wan (Sites 17c and 17e) (*Table 5.9* and *Table B4* of *Annex B*). The size of individual habitat areas re-identified from Freshwater/ Brackish Wetland is listed in *Table E4a* of *Annex E*.

Table 5.9 Number and Percentage of Freshwater/Brackish Wetland Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 104)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Lowland Forest	2	1.9
Shrubby Grassland	3	2.9
Cultivation	30	28.8
Grassland	6	5.8
Other	24	23.1
Lowland Forest + Other	1	1.0
Lowland Forest + Plantation or Plantation/Mixed Forest	1	1.0
Lowland Forest + Grassland	1	1.0
Mixed Shrubland + Shrubby Grassland	1	1.0
Mangrove + Other	1	1.0
Lowland Forest + Plantation or Plantation/Mixed Forest + Other	1	1.0
Total:	71	68.3

Ecological Value Assessment: Four of the wetland patches surveyed, ie Tai Wan (Site 2g) and Ma Tso Lung (Sites 5a, 5b and 5c) in the northern New Territories, constituting about 3.8% of total wetland sub-sites, were considered to possess unique features and an ecological value of high* was given (*Annex D*). These habitats were found to be comparatively large in size, extensive in

areal extent and supported comparatively higher species diversity and abundance. Disturbance to these habitats due to human activities was little because of their remote nature (*Annex C2a* of *Annex C*).

The ecological values of 17 correctly mapped wetland sub-sites (areas scattered in the New Territories, ie Kam Tin, Sha Tau Kok and Sai Kung) were downgraded due to the observed disturbance from urban development, pollution and farming activities. A few of the surveyed areas were disturbed by dumping (eg Site 1c) and construction activities (eg Sites 4c and 14a) (*Table C2a* of *Annex C*). Among the 17 value-downgraded sub-sites (constituting about 16.3% of the total sub-sites surveyed for wetland), 15 of them (ie Sites 1c, 2b, 3e, 4c, 4e, 7b, 7c, 9d, 11d, 14a, 14d, 14e, 14f, 18b and 20a) had their ecological value re-adjusted from high to medium and two of them (ie Sites 6a and 18a) re-assessed from high to low.

Some of the small wetlands surveyed were found to be polluted by the drainage channels nearby and with deteriorating water quality. These habitats were largely colonized with weedy species and their ecological value was downgraded from high to medium (eg Sites 14d, 14e and 18b) (*Table C2a* of *Annex C*). The wetland identified for Site 6a in San Tin was found to be severely polluted and support low species diversity. In addition, tire dumping was observed on the riverbank. The ecological value of the habitat was downgraded from high to low. The areas influenced by the pollution could be considered for upgrade when the adverse influences are dealt with (and perhaps remedial measures taken).

A total of 9.8 hectares of correctly mapped wetland had their ecological value downgraded from high to medium and about 1.8 hectare of the habitat was given a low ecological value (*Table E4b* of *Annex E*).

The locations of freshwater/brackish wetlands where habitat re-identification and/or ecological value adjustments have been made are given in *Figure F4* of *Annex F*.

Information Gaps

A total of 104 sub-sites including 229.8 ha were verified in the present Study. There remain about 658 hectares of wetlands identified on the habitat map not surveyed in the previous and present studies. The existing status and ecological value of those habitats remains to be confirmed.

5.3.5 Natural Watercourse

Previous Study

An effort of 14.5 field days had been allocated to Natural Watercourse in the previous Study and a total of 53 sub-sites were surveyed. The results obtained from the previous field surveys showed that about 50% of the natural watercourse sub-sites were mapped accurately. The majority of the mis-identified sub-sites were actually modified watercourses. Such a change in the habitat type could have occurred after the satellite imagery and aerial

photos used for the previous Study were taken. Some of the watercourses had been re-mapped as wetlands, mangrove or grassland (see *Final Report* of previous Study).

Present Study

The present Study has assigned 25 days of field effort to verify the habitat type and ecological ranking of Natural Watercourse. Field surveys commenced on 15 December 2002 and completed on 31 March 2003 (*Table 5.10*). A total of 97 sub-sites were surveyed and their locations are shown in *Figure 5.3e*.

Table 5.10 Survey Schedule for Natural Watercourse

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Pak Nai	3	15 December 2002
2	Lung Kwu Tan	3	16 December 2002
3	Tai Tong	5	20 December 2002
4	Kam Tin	4	21 December 2002
5	Tsing Yi	5	24 December 2002
6	Kwun Tung	3	28 December 2002
7	Lung Yeuk Tau	4	30 December 2002
8	Shek Kong	4	1 January 2003
9	Tai Po	2	5 January 2003
10	Ho Chung	3	11 January 2003
11	Wah Fu	4	12 January 2003
12	Tai Shui Hang	5	27 March 2003
13	Cheung Sha	4	25 March 2003
14	Sham Wat Wan	1	2 April 2003
15	Tai Ho Wan	3	3 April 2003
16	Tai Long	2	31 March 2003
17	Sai Sha	4	19 January 2003
18	Gold Coast/So Kwun Wat	6	25 January 2003
19	Ting Kok	5	1 February 2003
20	Ma Wan	3	26 March 2003
21	Sha Tau Kok	6	8 February 2003
22	Lady Maclehose Holiday Village	4	15 February 2003
23	Plover Cove Country Park	4	12 March 2003
24	Tai Mo Shan	5	30 January 2003
25	Hoi Ha Road	5	23 February 2003
		Total: 97	

Habitat Mapping: The mapping accuracy of the natural watercourse habitats after verification is moderate. A total of 58 sub-sites surveyed were mapped correctly as Natural Watercourse.

The majority of the mis-mapped sub-sites (33 out of 39) were actually modified watercourses. A number of them were found to have been channelised and support low species diversity (eg Sites 2a and 3c). These channelised watercourses were therefore re-classified as Modified

Watercourse (*Table 5.11* and *Table B5* of *Annex B*). Most of the re-classified modified watercourses were given a low indicative ecological value except for Sites 7b, 12a, 12c and 13d where a medium ecological value was assigned due to the comparatively higher species diversity recorded for the habitats (*Table C3b* of *Annex C*).

Some of the habitats surveyed were found to be occupied by vegetation habitats, such as lowland forest (Sites 5c and 19e), mixed shrubland (Sites 15b and 23d) and cultivation (Site 18d) and they were respectively re-classified to the appropriate habitat categories (*Table 5.11* and *Table B5* of *Annex B*). One of the sub-sites surveyed in Tai Ho Wan was found to be a marine area near the North Lantau Expressway and thus not classified under the present mapping exercise. The size of individual re-identified habitat areas is presented in *Table E5a* of *Annex E*.

Table 5.11 Number and Percentage of Natural Watercourse Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 97)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Lowland Forest	2	2.1
Mixed Shrubland	2	2.1
Cultivation	1	1.0
Modified Watercourse	33	34.0
Marine Area	1	1.0
Total:	39	40.2

Ecological Value Assessment: Six of the surveyed sub-sites of natural watercourse habitats, including Site 14a in Sham Wat Wan, Sites 16a and 16b in Tai Long, Sites 20b and 20c in Ma Wan and Site 25e near Hoi Ha Road, were recorded to be comparatively large in size, truly natural, relatively free from human disturbance and support comparatively high species diversity. Wagtail (*Motacilla* spp.) was frequently encountered in this habitat during the field surveys indicating low disturbance. These habitats were considered to be pristine natural watercourses in Hong Kong and contained unique features that distinguished them from habitats of the same category. An ecological value of high* was assigned (*Annex D*). These high* natural watercourses constituted about 6.2% of the total sub-sites surveyed for the habitat.

Eight of the watercourse sub-sites (ie about 8.2% of total natural watercourse sub-sites) were found to have been disturbed by pollution and urban development and their ecological value was downgraded to medium (Sub-sites 3a, 3e, 8d, 11d, 12b, 12d, 12e and 18d). Two watercourse areas were seen to have been severely affected by sewage pollution and their ecological value was downgraded to low (Sites 6b and 18a) (*Table C3a* of *Annex C*). In total, there were 10 sub-sites downgraded in term of their ecological value and constituted about 10.3% of the total sub-sites surveyed for Natural Watercourse. The total natural watercourse area downgraded to medium and low ecological value was 0.49 hectare and 0.52 hectare, respectively (*Table E5b* of *Annex E*).

Figure F5 of *Annex F* shows the sub-site locations of Natural Watercourse where habitat re-identification and/or ecological value adjustments have taken place based on field survey results.

Information Gaps

There were a total of 97 sub-sites including 34.1 ha surveyed and verified in the present Study. Apart from those watercourses surveyed under the previous study, there are still about 548 hectares of natural watercourses yet to have their habitat type and ecological status confirmed.

5.3.6 Mangrove

Previous Study

The mangrove habitat had been given 6 days of field effort in the previous Study. A total of 21 patches of mangrove were surveyed and the majority of the habitats were mapped correctly. Most of the mangrove sites were considered high ecological value after field assessment of the previous Study as they supported moderate to high species diversity, and were subject to little or no human disturbance.

Present Study

The 7 days of field effort allocated to Mangrove under the present Study were completed during the period from 19 February 2003 to 1 March 2003 (*Table 5.12*). A total of 52 patches (sub-sites) of mangrove were visited and their habitat boundary and ecological ranking were checked and evaluated. *Figure 5.3f* shows the locations of the surveyed mangrove sub-sites.

Table 5.12 Survey Schedule for Mangrove

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Lau Fau Shan	2	26 February 2003
2	Mai Po Nature Reserve	16	24 February 2003
3	Sha Tau Kok	14	19 February 2003
4	Ting Kok	5	22 February 2003
5	Wong Ma Tai	3	23 January 2003
6	Kei Ling Ha Lo	3	27 January 2003
7	Marina Cove	9	1 March 2003
	Total:	52	

Habitat Mapping: The mangrove habitats in some of the survey sites are located continually along a coastline (eg Site 1 Lau Fau Shan, Site 4 Ting Kok, Site 5 Wong Ma Tai and Site 6 Kei Ling Ha Lo) while some mangroves were seen to be distributed in a scattered manner (eg Site 2 Mai Po Nature Reserve, Site 3 Sha Tau Kok and Site 7 Marina Cove).

The mapping accuracy of the mangrove after verification is moderate with some adjustment to the habitat boundary. Among the 52 sub-sites surveyed, a

total of 20 sub-sites were found to be partially or wholly mis-identified and re-classification was required.

Some of the mangrove habitats within the Mai Po Nature Reserve were re-identified as Fishpond/Gei Wai (Sites 2d, 2g, 2i and 2j-o) after field assessment (*Table 5.13* and *Table B6a* of *Annex B*). These re-identified fishponds/gei wais were given a high ecological value due to the conservation importance of the fishpond system in the Mai Po Natural Reserve [1][2] and this was already reviewed and documented in the previous Study [3].

For some of the mangrove sub-sites surveyed, the landward portion of the mapped area is actually a forest, mixed shrubland or cultivated land and was thus re-classified as Lowland Forest (Sites 4a, 7a, 7c and 7i), Mixed Shrubland (Sites 5a, 5b and 5c) or Cultivation (Site 6a), respectively. Some of the sub-sites (eg Sites 4a, 4e, 5b, 6a, 7a, 7c, 7d, 7g and 7i) had their seaward portion being occupied by mudflats and were therefore re-identified as Intertidal Mudflat. (*Table 5.13* and *Table B6a* of *Annex B*). The area of the habitats re-classified from Mangrove is presented in *Table E6a* of *Annex E*.

Table 5.13 Number and Percentage of Mangrove Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 52)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Mixed Shrubland	2	3.8
Intertidal Mudflat	3	5.8
Fishpond/Gei Wai	9	17.3
Lowland Forest + Intertidal Mudflat	4	7.7
Mixed Shrubland + Intertidal Mudflat	1	1.9
Cultivation + Intertidal Mudflat	1	1.9
Total:	20	38.5

Under-mapping of habitat area was recorded in 35 of the sub-sites surveyed for Mangrove (*Table B6b* of *Annex B*). The actual extended boundary was re-identified on the habitat map and a high ecological value was assigned. Fifteen habitat types, including Lowland Forest, Mixed Shrubland, Freshwater/Brackish Wetland, Natural Watercourse, Seagrass Bed, Intertidal Mudflat, Shrubby Grassland, Sandy Shore, Cultivation, Fishpond/Gei Wai, Bare Rock or Soil, Grassland, Modified Watercourse, Rural Industrial Storage/Containers and Other, were affected by the extension of the mangrove area (*Table E6b of Annex E*). About 0.092 hectare of marine area was affected by the mangrove extension (*Table E6b of Annex E*).

Ecological Value Assessment: The mangrove at Mai Po Nature Reserve, Sha Tau Kok and Ting Kok were found to be densely vegetated with mangrove trees and support high species diversity. The height of mangrove trees (ie

(1) Town Planning Board (1999) Town Planning Board Guidelines for Application for Developments within Deep Bay Area under Section 16 of the Town Planning Ordinance. PB PG-No. 12B (Revised April 1999).

(2) Aspinwall & Company (1997) Study on the Ecological Value of Fish Ponds in Deep Bay Area. Executive Summary to the Planning Department of the Hong Kong SAR Government, September 1997.

(3) ERM-Hong Kong, Ltd (2000) *Op cit.*

Kandelia candel, Avicennia marina and *Aegiceras corniculatum*) recorded in some other survey sites (eg Wong Ma Tai, Kei Ling Ha Lo and Marina Cove) are generally less than 1.5 m. Some of these mangrove habitats within the Mai Po Nature Reserve were re-identified as Fishpond/ Gei Wai (Sites 2d, 2g, 2i and 2j-o) after field assessment and a high ecological value was assigned since the fishponds/gei wais are located within the Mai Po Nature Reserve and have been confirmed as of significant conservation importance[1][2][3] (*Table C4b* of *Annex C*).

The mangrove at Ting Kok was found to be densely vegetated with mangrove trees and supported high species diversity. The height of mangrove trees (ie *Kandelia candel, Avicennia marina* and *Aegiceras corniculatum*) recorded in some other survey sites (eg Sha Tau Kok, Wong Ma Tai, Kei Ling Ha Lo and Marina Cove) are generally less than 1.5 m. The mangrove sub-site at Sha Tau Kok (Site 3n) was considered as one of Hong Kong' s most pristine natural mangroves as the habitat is truly natural and adjoined to a large brackish wetland. The habitat was regarded as of possessing a unique feature and an ecological value of high* was assigned (*Annex D*).

Some locations of the mangrove sites were found to have been disturbed by sewage pollution (eg Lau Fau Shan, Sha Tau Kok and Kei Ling Ha Lo). Mangrove cutting was observed in Lau Fau Shan and Kei Ling Ha Lo. Despite the slight disturbance to some of the survey sites, the majority of the mangrove habitat identified was given a high ecological value. Five of the 52 mangrove sub-sites, constituting about 9.6% of the total sub-sites surveyed for Mangrove, had their ecological value downgraded from high to medium. These downgraded patches are located at Sha Tau Kok (Sites 3b-d, 3j and 3l) and the ecological value adjustment was due to the observed severe disturbance due to sewage pollution and littering (*Annex C4a* of *Annex C*). The areas influenced by the pollution could be considered for upgrade when the adverse influences are dealt with (and perhaps remedial measures taken). The total area of mangrove downgraded from high to medium ecological value was 3.3 hectares (*Table E6c of Annex E*).

The sub-site location of Mangrove where habitat re-identification and/or ecological value adjustment have occurred based on field surveys are provided in *Figure F6* of *Annex F.*

Information Gaps

A total of 52 patches representing about 17 hectares of mangrove were surveyed and verified in this Study. Apart from those that had been surveyed in the previous and present studies and where existing information is available to substantiate their existence and ecological rating, there are still some mangrove stands (eg Tai Po Kau, Yi O and Yung Shue Au) which lack verification.

(1) Town Planning Board (1999) *Op cit.*

(2) Aspinwall & Company (1997) *Op cit.*

(3) ERM-Hong Kong, Ltd (2000) *Op cit.*

5.3.7 Intertidal Mudflat

Previous Study

In the previous Study, a total of 24 sub-sites of Intertidal Mudflat were surveyed within 9 survey days. Most of the surveyed sites were mapped correctly with a few of them recorded as fringe patches of mangrove or sandy substratum with cobbles of various sizes(1).

Present Study

A total of 8 sites (9 sub-sites) of intertidal mudflats were surveyed during the period from 12 February 2003 to 2 March 2003 for this Study (*Table 5.14*). The locations of the surveyed sites are presented in *Figure 5.3g*.

Table 5.14 Survey Schedule for Intertidal Mudflat

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Sha Kiu Tsuen/Nam Sha Po	1	25 February 2003
2	Sha Tau Kok	1	18 February 2003
3	Ting Kok	1	21 February 2003
4	Kai Ma Tung	1	20 February 2003
5	Ngo Keng Tsui	1	17 February 2003
6	Ko Tong Hau	2	28 February 2003
7	Tai Chau	1	2 March 2003
8	Tong Fuk Miu Wan	1	12 February 2003
		Total: 9	

Habitat Mapping: The intertidal mudflats in all the surveyed sites are largely distributed continuously along a coastline. Most of the surveyed intertidal mudflats are covered with scattered cobbles and/or boulders, particularly on the upper tidal zone. The mapping accuracy of the Intertidal Mudflat after verification is generally high.

Excluding those sub-sites re-classified into more than one habitat type, four of the mudflat habitats (sub-sites) have a small portion of the habitat area (5 - 10%) re-classified as Mangrove (Sites 1a, 3a, 7a and 8a) (*Table 5.15* and *Table B7* of *Annex B*). About 5% of two of the sub-sites were re-classified as Mangrove and Seagrass Bed (Sites 2a and 6a). Seagrass species *Halophila ovalis* was recorded in Sites 2a and 6a and the area occupied by the species was thus re-identified as Seagrass Bed. Sparse patches of another seagrass species *Halophila beccarii* was observed in Site 1a, however, the area occupied by the species was very small and re-classification of the habitat area to Seagrass Bed was considered not necessary.

About 50% of the mudflats in Kai Ma Tung (Site 4a) and Ngo Keng Tsui (Site 5a) were re-classified as Mangrove, Rocky Shore and Sandy Shore and their respective indicative ecological values (ie high for mangrove and medium for

(1) ERM-Hong Kong, Ltd (2000) *Op cit.*

rocky and sandy shore) were assigned. The area of habitat types re-identified from Intertidal Mudflat is provided in *Table E7 of Annex E*.

Table 5.15 Number and Percentage of Intertidal Mudflat Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 9)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Mangrove	4	44.4
Mangrove + Seagrass Bed	2	22.2
Mangrove + Rocky Shore + Sandy Shore	2	22.2
Total:	8	88.9

Ecological Value Assessment: Among the sites surveyed, the most intact mudflat is located at Tong Fuk Miu Wan (Site 8a) in South Lantau where the habitat is large in size and supports high species diversity. In addition, the area was reported to be the nursery ground of horseshoe crab juvenile and the only reported site for the gastropod *Umbonium* sp. An ecological value of high* was therefore assigned to the habitat (*Annex D*).

Two rare species, *Halophila ovalis* (seagrass) and *Hippocampus kuda* (seahorse) were recorded in Ko Tong Hau (Site 6a) during the field survey. *Halophila ovalis* was also observed in Sha Tau Kok (Site 2a) and sparse patches of another seagrass species *Halophila beccarii* was recorded in Sha Kiu Tsuen/Nam Sha Po (Site 1a). Some of the survey locations were found to have been disturbed by sewage pollution (eg Sha Tau Kok). Despite the slight disturbance observed during the surveys, the ecological values of all the correctly mapped intertidal mudflats were high.

The locations of Intertidal Mudflat sub-sites where habitat re-identification and/or ecological value adjustment have taken place are given in *Figure F7* of *Annex F*.

Information Gaps

A total of 9 sub-sites of an approximately area of 43 hectares were surveyed and verified in this Study. There are still some identified mudflat habitats (about 1,217 hectares) left unsurveyed under the previous and present studies or lack sufficient existing information to substantiate their indicative high ecological ranking. Efforts may be required in the future to verify the boundary and ecological value of these habitats.

5.3.8 Shrubby Grassland (including Baeckea Shrubland)

Previous Study

In the previous Study, a total of 14 days had been allocated to Shrubby Grassland and *Baeckea* Shrubland and a total of 121 patches (sub-sites) of these two habitat types had been surveyed. A number of the mapped locations were found to be mis-classified and represented other habitat categories (eg Lowland Forest, Mixed Shrubland, Plantation or Plantation/Mixed Forest and Grassland).

Present Study

A total of 30 days have been assigned to Shrubby Grassland in this Study and field surveys for this habitat category were completed by 7 March 2003 (*Table 5.16*). The locations of the 183 sub-sites surveyed are shown in *Figure 5.3h*.

Table 5.16 Survey Schedule for Shrubby Grassland

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Yuen Long	6	6 December 2003
2	So Kwun Wat	5	9 February 2003
3	Plover Cove Country Park	6	17 December 2002
4	Ho Chung	7	13 December 2002
5	The Peak	6	3 January 2003
6	Shek Mun Kap	4	22February 2002
7	Tai Mo Shan Country Park	8	28 January 2003
8	Shek O Country Park	6	20 December 2002
9	Sai Kung West Country Park	8	8 January 2003
10	Tai Lam Country Park	6	6 January 2003
11	Tai Leng Tung	2	17 January 2003
12	Chok Ko Wan Tsui	8	31 December 2002
13	Beacon Hill	4	3 March 2003
14	Robin's Nest	7	16 January 2003
15	Pak Shek Au	3	3 December 2002
16	Pai Tan Tun	3	23 January 2003
17	Ha Tsuen	7	15 January 2003
18	Tai Tam Country Park	8	10 January 2003
19	Cloudy Hill	7	14 January 2003
20	Lam Tsuen Country Park	5	7 February 2003
21	Tai Po Kau Nature Reserve	9	2 December 2002
22	Long Hill	3	30 January 2003
23	Kadoorie Farm	4	29 November 2003
24	Shek Pik	7	27 January 2003
25	Mount Butler	9	15 January 2003
26	Tai Shui Hang	7	22 January 2003
27	Sai Kung	6	6 February 2003
28	Tuen Mun	5	7 March 2003
29	Ma Liu Shui	9	21 January 2003
30	Lam Tsuen Country Park	8	9 January 2003
		Total: 183	

Habitat Mapping: Among the 183 sub-sites surveyed for Mixed Shrubland, 62 of them were mapped correctly. About 52% (95 sub-sites) of the shrubby grassland sub-sites have been re-classified as Mixed Shrubland after site verification as these sites were seen to be occupied by more than 50% of shrub species. The mis-classification could possibly be due to the spectral similarity of mixed shrubland to shrubby grassland, their tendency to intermingle with each other, and the gradual natural succession of shrubby grassland to mixed shrubland that might have occurred after the time when satellite imagery and

aerial photographs were taken during the previous Study. Some of the sub-sites (eg Sites 4a and 30b), especially those with graves nearby, were found to have been disturbed by fire and lots of woody species had invaded into and dominated the areas. These sites have also been re-classified as Mixed Shrubland and an ecological value of high was assigned (*Table 5.17* and *Table B8* of *Annex B*).

Eight of the sub-sites (Sites 5a, 5b, 5d, 5e, 5f, 18g, 18h and 27c) were actually occupied by lowland forests and were thus re-classified under the "Lowland Forest" category and an indicative ecological value of high was assigned. One sub-site in Chok Ko Wan Tsui (Site 12g) was found to be covered by a wetland and was re-mapped as Freshwater/Brackish Wetland and a high indicative ecological value was given. Eight of the sub-sites surveyed were found to be covered by cultivated land instead of shrubby grassland. Some of these re-identified cultivation (eg Site 8e) were actually planted with orchards, such as *Litchi chinensis* and *Dimocarpus longan.* These areas were therefore re-classified as Cultivation and an indicative ecological value of medium was assigned (*Table 5.17* and *Table B8* of *Annex B*).

There were nine sub-sites of Shrubby Grassland re-identified as Other. Some of the sub-sites of Beacon Hill (eg Site 13a) appeared to have been disturbed by nearby villagers and become a wasteland. Some habitats have been modified into a landscape planting area (eg Sites 12h, 21f, 21g and 21h). These sub-sites were re-identified as Other and an ecological value of negligible was assigned (*Table 5.17* and *Table B8* of *Annex B*).

The area of habitats re-identified from Shrubby Grassland (including *Baeckea* Shrubland) is presented in *Table E8a* of *Annex E*.

Table 5.17 Number and Percentage of Shrubby Grassland Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 183)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Lowland Forest	8	4.4
Mixed Shrubland	95	51.9
Freshwater/Brackish Wetland	1	0.5
Cultivation	8	4.4
Other	9	4.9
	Total: 121	66.1

Ecological Value Assessment: The majority of the identified shrubby grassland was regarded as of medium ecological value and no value adjustment was required. Most of the shrubby grassland were found to be patchy and structurally less complex than most of the mixed shrubland surveyed. Only one sub-site (Site 10e) in the Tai Lam Country Park was downgraded from medium to low ecological value as the habitat was small in size, relatively open in vegetation structure and supported comparatively low species diversity (*Table C5* of *Annex C*). The percentage of sub-site downgraded was 0.55% of the total sub-sites surveyed for Shrubby Grassland.

The area of the downgraded shrubby grassland was 0.11 hectare (*Table E8b* of *Annex E*).

The sub-site locations of Shrubby Grassland where habitat re-classification and/or ecological value adjustments have occurred are shown in *Figure F8* of *Annex F.*

Information Gaps

A total of 183 sub-sites of approximately 320 hectares have been surveyed and verified in the present Study. There are still about 14,019 hectares of shrubby grassland (including *Baeckea* Shrubland*)* not covered by the previous and present field surveys and their existing boundary and ecological value remain to be field verified.

5.3.9 Sandy Shore

Previous Study

Four days of survey effort had been budgeted to Sandy Shore in the previous Study and a total of 10 sub-site beaches were surveyed. The majority of the sites surveyed were mapped with 100% accuracy.

Present Study

The same number of survey days (ie 4) has been allocated to Sandy Shore for this Study and surveys were conducted during the period from 11 to 27 February 2003 (*Table 5.18*). A total of 22 sub-sites were surveyed for Sandy Shore and their locations are presented in *Figure 5.3i.*

Table 5.18 Survey Schedule for Sandy Shore

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Pak Nai	3	27 February 2003
2	Hung Fan Shek	4	11 February 2003
3	Chi Ma Wan	5	18 February 2003
4	Fan Lau	10	19 February 2003
		Total: 22	

Habitat Mapping: A total of 4 sites (22 sub-sites) were surveyed and the mapping accuracy of the sandy shore habitats after verification is generally high. Three sandy shores (Sites 2c, 2d and 3a), constituting about 13.6% of the total sub-sites surveyed for the habitat, were re-identified as Rocky Shore and a medium ecological value was assigned (*Table B9a* of *Annex B*).

Two of the sandy shore sub-sites (Sites 3b and 3c) were found to be under-estimated in their areal extent (*Annex B9b* of *Annex B*). The actual extended boundary was re-identified on the habitat map and a medium ecological value was assigned. The total extended area was 0.30 hectare (*Annex E9b* of *Annex E*).

Ecological Value Assessment: Most of the sandy shores surveyed showed limited species diversity and faunal abundance. The survey sub-sites at Fan Lau (Sites 4a, 4b and 4d) were found to be extensive and remote to urban areas without disturbance due to human activities. These habitats were considered to be pristine sandy shores in Hong Kong and is relatively unique when compared to other areas of the same category in Hong Kong. An "*" was thus designated to these sub-sites (*Annex D*). The three sub-site patches with a "high*" ranking constituted about 13.6% of the total sub-sites surveyed for Sandy Shore.

However, one of the sub-sites in Hung Fan Shek (Site 2a) is close to a village and appeared to have been considerably disturbed by sewage pollution and ecological value has been downgraded to low (*Table C6* of *Annex C*). The habitat could be considered for upgrade when the adverse influences are dealt with (and perhaps remedial measures taken). The sandy shores at Chi Ma Wan (Site 3) were also found to have been disturbed as solid wastes were observed on the shores. After the field assessment, the majority of the surveyed sites were given an ecological value of medium. The downgraded sub-site constituted about 4.5% of the total number of sub-sites surveyed for Sandy Shore. The total area of sandy shore downgraded from medium to low was 0.49 hectare (*Table E9b* of *Annex E*).

The locations of sandy shore sub-sites where re-classification of habitat type and/or re-assessments of ecological value have taken place are presented in *Figure F9* of *Annex F.*

Information Gaps

A total of 22 sandy beaches comprising 14.7 km have been surveyed during the present Study. Taking into account the sandy shores reviewed and surveyed in the previous Study, there remains a total of about 127 km of the habitat unsurveyed and no data are available to justify their ecological value (*Table 2.1*). Further survey efforts may be devoted to those sheltered sandy shores which are located in very remote areas, eg North-east New Territories, where upgrading of indicative ecological value may be necessary.

5.3.10 Rocky Shore

Previous Study

In the previous Study, a total of 4 days were assigned to validate the habitat type and assess the conservation value of Rocky Shore. The habitat was mapped with high accuracy and all the shores selected for surveys were identified correctly.

Present Study

This Study has allocated a total of 5 days to the rocky shore habitat. Field surveys commenced in early December 2002 and were completed on 5 April 2003 (*Table 5.19*). A total of 21 sub-sites were surveyed and their locations were shown in *Figure 5.3j.*

Table 5.19 Survey Schedule for Rocky Shore

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Hei Ling Chau	4	19 February 2003
2	Tung Lung Chau	4	4 December 2002
3	Sai Kung	4	1 April 2003
4	Tap Mun	6	4 April 2003
5	Tung Wan Shan	3	5 April 2003
		Total: 21	

Habitat Mapping: The mapping accuracy of the rocky shore after verification is generally high. Minor adjustments were made to Sites 1b, 1d and 2d where a small part (about 5%) of the surveyed sub-site was re-classified as Sandy Shore. One sub-site of Tap Mun (Site 4a) was found to be occupied by mangrove and an indicative ecological value of high was assigned. Another sub-site of Tap Mun (Site 4c) was actually an artificial rocky/hard shore and a low ecological value was given (*Table 5.20* and *Table B10a* of *Annex B*). The extent of rocky shore re-identified into other habitat types is given in *Table E10a* of *Annex E*.

Table 5.20 Number and Percentage of Rocky Shore Mis-identified Sub-sites (Total Number of Sub-sites Surveyed = 21)

Habitat Type of Mis-identified Area	No. of Sub-sites	Percentage (%)
Mangrove	1	4.8
Sandy Shore	3	14.3
Artificial Rocky/Hard Shoreline	1	4.8
Total:	5	23.8

Four of the rocky shores surveyed, including Sites 1b, 1d, 2d and 4f, were found to be under-mapped in their extent (*Annex B10b* of *Annex B*). The actual extended boundary was re-identified on the habitat map and a medium ecological value was assigned. The total length re-classified to Rocky Shore was 0.23 km (*Annex E9b* of *Annex E*).

Ecological Value Assessment: All the surveyed locations are outlying islands or peninsulas and away from urban areas and little disturbance was observed for the most of the sub-sites surveyed.

Only one sub-site, located at Tap Mun (Site 4d), had its ecological value downgraded to low because of disturbance from pollution and development that the habitat is subject to (*Table C7* of *Annex C*). The areas influenced by the pollution could be considered for upgrade when the adverse influences are dealt with (and perhaps remedial measures taken). The length of the rocky shore downgraded to low ecological value was 0.28 km (*Annex E10c* of *Annex E*).

The survey sub-sites of the outlying islands and remote areas, including Sai Kung (Sites 3a, 3b, 3c and 3d), Tap Mun (Sub-site 4f) and Tung Wan Shan (Sites 5a-c), were considered to possess unique features and an ecological

value of medium* was assigned (*Table C7* of *Annex C*). These rocky shores were found to be extensive and supported comparatively higher species diversity and abundance than other rocky shores in Hong Kong. Disturbance to these habitats due to human activities was limited because of their remoteness to urban areas. The sub-sites with a "medium*" ecological value constituted about 38.1% of the total number of sub-sites surveyed for Rocky Shore.

The locations of rocky shore sub-sites where re-classification of habitat type and/or re-adjustments of ecological value have occurred are shown in *Figure F10* of *Annex F*.

Information Gaps

A total of 21 sub-sites have been surveyed in this Study and a total of 33.8 km have been verified. There are still about 654 km rocky shores where surveys have yet to be undertaken and therefore data are not available to justify their ecological value (*Table 2.1*). Further efforts may be required to survey those exposed rocky shores which are located in very remote areas, eg outlying islands, where upgrading of indicative ecological value may be necessary.

5.3.11 Cultivation

Previous Study

The previous Study had surveyed a total of 45 sub-sites of cultivation using the 8 days of survey effort assigned to the habitat category. Some of the habitat areas had become developed or industrial storage areas and these have been re-classified as Other. Some other sites were actually occupied by shrubs and grasses and were thus re-classified as either Mixed Shrubland, Shrubby Grassland or Grassland.

Present Study

A total of 10 days have been given to Cultivation in this Study. Field surveys were undertaken during the period from 29 November 2002 to 2 March 2003 (*Table 5.21*). A total of 10 sites (81 sub-sites) were surveyed and their locations are shown in *Figure 5.3k*.

Table 5.21 Survey Schedule for Cultivation

Site No.	Survey Location	Number of Sub-sites	Survey Date
1	Lau Fau Shan	6	25 February 2003
2	Lam Tei	6	13 January 2003
3	Kam Tim/ Shek Kong	7	25 February 2003
4	Tai Lam Country Park	9	9 January 2003
5	Kwan Tei	14	2 March 2003
6	Wong Yue Tan/ Ha Tai Ha	8	26 February 2003
7	Shap Sze Heung	7	26 February 2003
8	Tung Chung Bay	6	22 February 2003

Site No.	Survey Location	Number of Sub-sites	Survey Date
9	Lam Tsuen Country Park	3	29 November 2002
10	Kwu Tong	15	1 March 2003
		Total: 81	

Mapping Accuracy: A total of 81 sub-sites were surveyed for Cultivation and 38 of them showed 100% accuracy. Among the 81 sub-sites surveyed, 13 of them (ie 16.0% of total sub-sites surveyed for Cultivation) were found to have been mis-identified and should all be re-classified as Other. Some cultivated lands have been modified due to urban development, for example conversion into a car park (eg Site 4c) and abandoned cultivation with dumps or fills (eg Site 7g). An indicative negligible ecological value was assigned to these re-identified habitats (*Table B11a* of *Annex B*). The area of cultivation re-classified under the "Other" category was 16.5 hectares (*Annex E11a* of *Annex E*).

The habitat area of 30 of the cultivation sub-sites surveyed was found to be under-mapped (*Table B11b* of *Annex B*). The actual extended boundary was re-identified on the habitat map and a medium ecological value was assigned. The habitats affected by the extension of the cultivation area included Fung Shui Forest, Lowland Forest, Mixed Shrubland, Freshwater/Brackish Wetland, Mangrove, Shrubby Grassland, Fishpond/Gei Wai, Bare Rock or Soil, Grassland, Rural Industrial Storage/Containers and Other, and the respective affected area is presented in *Table E11b* of *Annex E*. The sub-site location of Cultivation where re-classification of habitat type had taken place is shown in *Figure F11* of *Annex F*.

Ecological Value Assessment: Many of the cultivation fields surveyed were found to support a number of cultivated vegetation species and fruit trees such as *Dimocarpus longan*, *Clausena lansium* and *Litchi chnensis* (eg Sites 1c, 1d, 4h, 4i, 3b, 5j, 5n, 5l, 10g and 10n). Some cultivation habitats in Kwan Tei (Sites 5a and 5d) and Kwu Tung (Sites 10b and 10e) were seen to be under active cultivation and their ecological value is on the low side of medium. Some wet abandoned cultivated land were identified during the field surveys (eg Sites 6e, 7d, 7e and 8c) and these habitats could possibly be developed into wetlands. The ecological value of these areas was considered to be on the high side of medium. In addition, a number of avifaunal species were seen during the site visits in areas near San Uk Tsai village (Sites 5a, 5b and 5c), Tai Lung and Ping Kong (Sites 10b and 10c) and Tsiu Keng (Sites 10i, 10j, 10k, 10h and 10l) and groups of birds were seen flying near Tsim Bei Tsui near Site 1a. This indicates the potential ecological importance of these habitats for wild birds.

Information Gaps

There were a total of 81 sub-sites including 219.2 ha have been verified in the present Study. There are still about 3,785 hectares of cultivation mapped on the habitat map left unsurveyed and uncertainties remain in these areas with regard to their habitat type and ecological status. As the habitat is highly heterogeneous in nature, further efforts may be required to differentiate cultivated land from other habitat type(s) to justify ecological rating.

5.3.12 Fishpond/Gei Wai

The mapping of the fishpond/gei wai habitats was updated through a comprehensive desktop review of the habitat type and boundary on the latest aerial photographs (2001; provided by SDU on 25 November 2002) against the habitat map prepared for the previous Study. Wherever appropriate, the following criteria were considered for assessing the ecological value of a fishpond/gei wai during the desktop checking exercise:

- size of the habitat; and
- presence of known ecologically important areas in its vicinity (if any).

Habitat Mapping: Most of the fishponds/gei wais have their boundary matched well with the habitats identified on the existing habitat map and the mapping accuracy is high. A few of the fishpond sites were seen to have been developed and therefore re-classified as Other. These locations include the car parks in Yuen Long rural area, the construction works areas in Tin Shui Wai Wetland Park, Kam Tin and Tolo Harbour Highway and the channelisation works at the Drainage Channel beside Tin Shui Wai. This could possibly be due to the development that have occurred in the past few years after the existing habitat map was established for the previous Study. The total "Other" area re-identified from Fishpond/Gei Wai was 69.1 hectares.

Ecological Value Assessment: The ecological value of the fishponds were assessed as far as possible based on the two criteria stated above. All the fishponds/gei wais reviewed in the present desktop exercise were given a medium ecological value and no adjustment was considered necessary.

It should be noted that the ecological value assessment was only based on a desktop review and a number of the criteria adopted for the previous field surveys were not included for consideration due to the limitation of the desktop exercise. These criteria include:

- management status: active or abandoned;
- structural complexity of vegetation (habitat heterogeneity);
- number and abundance of faunal and floral species groups encountered;
- presence of "rare" species (if any); and
- degree of disturbance and damage (if any).

The data for the above attributes can only be obtained through actual field visits.

Information Gaps

The habitat mapping of fishponds/gei wais has been updated using the latest aerial photos (2001). Ecological value of the habitats not surveyed in the previous Study may require field surveys to verify their ecological value.

5.3.13 Plantation or Plantation/Mixed Forest

Digital data on the locations and boundaries of plantations were provided courtesy of the Agriculture, Fisheries and Conservation Department (AFCD). The plantation data contain 179 plantation patches constituting approximately 532.3 hectares within the HKSAR. The plantation sites were seen to cover a variety of habitat types, including Lowland Forest, Mixed Shrubland, Freshwater/Brackish Wetland, Natural Watercourse, Shrubby Grassland, Plantation or Plantation/Mixed Forest, Cultivation, Fishpond/Gei Wai, Bare Rock or Soil, Grassland, Modified Watercourse, Quarry and Other when the polygon data were overlaid onto the existing habitat map. The habitat type and their respective ecological value and size (in hectare) are presented in *Table 5.22*.

Table 5.22 The Habitat Type, Ecological Value and Size of Habitats within the AFCD Plantation Sites

Habitat Type	Size (Hectare)
High Ecological Value	
• Lowland Forest	7.95
• Mixed Shrubland	58.87
• Freshwater/Brackish Wetland	0.36
• Natural Watercourse	1.96
• Fishpond/Gei Wai	2.85
Sub-total:	**72.0**
Medium Ecological Value	
• Natural Watercourse	0.43
• Shrubby Grassland (including *Baeckea* Shrubland)	107.29
• Plantation or Plantaion/Mixed Forest	0.02
• Cultivation	0.90
• Fishpond/Gei Wai	0.30
• Grassland	109.53
• Other	0.01
Sub-total:	**218.5**
Low Ecological Value	
• Bare Rock or Soil	7.19
• Grassland	198.18
• Modified Watercourse	1.01
• Quarry	11.46
Sub-total:	**217.8**
Negligible Ecological Value	
• Other	24.0
Sub-total:	**24.0**
Total:	**532.3**

A total of 6 surveyed locations, mapped as Mixed Shrubland after field verification undertaken for this Study, were identified within the AFCD plantation sites. These areas constituted a total land cover of approximately 4.4 hectares (*Table 5.23*).

Table 5.23 ***The Name of Sub-site, Habitat Type Classified after Field Survey in the Present Study and Size of the Surveyed Area Intercepted with AFCD' s Plantation Sites***

Sub-site	Habitat Type before Field Surveys in the Present Study	Habitat Type after Field Surveys in the Present Study	Size of Intercepted Area (Hectare)
Mixed Shrubland Site 2b	Mixed Shrubland	Mixed Shrubland	1.46
Mixed Shrubland Site 30a	Mixed Shrubland	Mixed Shrubland	1.02
Mixed Shrubland Site 30d	Mixed Shrubland	Mixed Shrubland	0.46
Mixed Shrubland Site 30e	Mixed Shrubland	Mixed Shrubland	0.48
Mixed Shrubland Site 30f	Mixed Shrubland	Mixed Shrubland	0.0042
Shrubby Grassland Site 1f	Shrubby Grassland	Mixed Shrubland	0.96
			Total: 4.4

The key results of field surveys for the six sub-site locations are summarized in *Table 5.24*.

Table 5.24 ***Key Survey Results of the Surveyed Sub-sites Located within AFCD' s Plantation Sites***

Sub-site	Key Results of Field Surveys
Mixed Shrubland Site 2b	The habitat appeared to be originated from a plantation comprised of *Pinus massoniana* as the key species. Judging by the growth of surrounding vegetation the planting works appear to have been conducted a couple of years previously. The habitat was found to be colonized by a number of native species including *Cratoxylum cochinchinense, Litsea rotundifolia* and *Microcos paniculata*. The condition of the sub-site fulfilled the agreed definition for Mixed Shrubland, ie land cover with less than 50% grasses with shrubs the major woody life form. The habitat area was classified as Mixed Shrubland and an ecological value of high was assigned.
Mixed Shrubland Site 30a	The habitat was found to be covered by native vegetation with more than 50% woody plant species such as *Gordonia axillaris, Itea chinensis* and *Eurya japonica*. The condition of the sub-site fulfilled the agreed definition for Mixed Shrubland. The habitat area was classified as Mixed Shrubland and an ecological value of high was assigned.
Mixed Shrubland Site 30d	The habitat was found to be covered by native vegetation with more than 50% woody plant species such as *Eurya japonica, Litsea rotundifolia* and *Aporusa dioica*. The condition of the sub-site fulfilled the agreed definition for Mixed Shrubland. The habitat area was classified as Mixed Shrubland and an ecological value of high was assigned.
Mixed Shrubland Site 30e	The habitat was found to be covered by native vegetation with more than 50% woody plant species such as *Ilex asprella, Itea chinensis* and *Litsea rotundifolia*. The condition of the sub-site fulfilled the agreed definition for Mixed Shrubland. The habitat area was classified as Mixed Shrubland and an ecological value of high was assigned.
Mixed Shrubland 30f	The habitat was found to be covered by native vegetation with more than 50% woody plant species such as *Sinosideroxylon wightianum, Rhaphiolepis indica* and *Helicia cochinchinensis*. The condition of the sub-site fulfilled the agreed definition for Mixed Shrubland. The habitat area was classified as Mixed Shrubland and an ecological value of high was assigned.
Shrubby Grassland Site 1f	The sub-site area was found to be covered by various woody species including such exotic species as *Pinus elliottii, Acacia auriculiformis* and *Lophostemon conferta*. The habitat was diverse in species composition. The sub-site was re-classified as Mixed Shrubland and an ecological value of high was assigned.

Based on the recommendations from AFCD (Correspondence dated 17 June 2003; *Ref: (25) in CSO/SDU/7/12 Pt.2*), all areas covered by the plantation areas, except for the habitats Natural Watercourse and Freshwater/Brackish Wetland should be changed to the category Plantation or Plantation/Mixed Forest and an indicative ecological value of medium should be assigned.

According to AFCD, the plantation areas are actual planting sites and have been planted for less than nine years. As tree planting in some of the sites was carried out as early as the early 1990s, vegetation at these sites may have grown to heights of trees and shrubs by the time the previous Study was carried out. Habitat maps based on remote sensing techniques would likely identify these plantation areas as Lowland Forest and Mixed Shrubland due to similar spectral reflectance of these habitats.

AFCD has confirmed that the habitat areas represented by the plantation polygons are actual plantation sites that have been planted for less than 9 years and/or are currently subject to regular maintenance management of the Government. In this regard, the habitat map has been revised, according to AFCD' s instruction, as follows:

- For non-plantation habitats with a lower than high ecological value (except for the 0.43 hectare of natural watercourse with a medium ecological value), ie Shrubby Grassland, Cultivation, Fishpond/Gei Wai, Bare Rock or Soil, Grassland, Modified Watercourse, Quarry and Other, they were re-classified under the "Plantation or Plantation/Mixed Forest" category and an indicative ecological value of medium was assigned.

- The 0.43 hectare of natural watercourse with a medium ecological value is retained under the category "Natural Watercourse" with no change in its ecological value.

- For the lowland forest, mixed shrubland and fishpond/gei wai habitats that were identified as of high ecological value on the conservation assessment map, the area was re-classified under the category "Plantation or Plantation/Mixed Forest" and a medium indicative ecological value was assigned.

- The natural watercourses (1.96 hectares) and wetlands (0.36 hectare) of high ecological value identified within the AFCD plantation sites are retained under the "Natural Watercourse" and "Freshwater/Brackish Wetland" categories with no change in their ecological value.

As a result of the above exercise, an addition of 529.5 hectares of plantation has been made to the habitat map. It should be noted that a plantation will eventually become a mixed shrubland or a forest through natural succession if time allows. Some of the "older" plantation areas (eg those sites planted for nearly or over nine years) may be selected for future habitat assessment and ecological value evaluation.

5.4 OTHER CONSERVATION COMPONENTS

The surveyors recorded opportunistic notes on the other two conservation components, ie landscape and recreational value, during their site visits and the data were incorporated into the conservation assessment map.

During ecological field surveys, landscape features including coastline, prominent watercourse and forest have been identified. These features were assessed against the criteria set forth for landscape value in the previous Study and a "+" was assigned to those habitat polygons where one or more valued landscape features were identified.

Recreational features such as campsites, barbecue site, education trails and hiking tails were observed in some of the surveyed sites, in particular within Country Parks. These features were assessed against the criteria set forth for recreational value in the previous Study and a "+" was assigned to those habitat polygons where one or more valued recreational features were identified.

5.5 MAPPING ACCURACY OF SURVEYED HABITATS BASED ON FIELD SURVEYS

The level of accuracy associated with the mapping of each of the surveyed habitats was calculated using estimates of accuracy recorded by surveyors when in the field. The total percentage of habitat correctly mapped was calculated by dividing the amount of habitat correctly mapped by the total amount surveyed. The total amount of habitat correctly mapped was calculated by taking the average accuracy for each site, multiplying that by the area of habitat within the site and summing these. The treatment is described by the following formula:

$$Total\ \%\ Accuracy = \sum_{i=1}^{n} \frac{Av.\ Accuracy\ of\ Site_i * Amount\ of\ Site_i}{Amount\ of\ Site_i\ Surveyed}$$

For habitat categories mapped with a spatial component, the amount mapped is measured using area. For habitat categories mapped with a linear component (eg Sandy and Rocky Shore), the amount mapped is measured using length.

5.5.1 Results of Mapping Accuracy of Surveyed Habitats Based on Field Surveys

The mapping accuracy calculated for each surveyed habitat type in this Study and the accuracy determined in the previous Study are presented in *Table 5.26*.

Table 5.26 Mapping Accuracy of Each Surveyed Habitat Category

Habitat Category	Overall Mapping Accuracy (Previous Study) (%)	Overall Mapping Accuracy (This Study) (%)
Fung Shui Forest[f]	N/A	N/A
Lowland Forest	69.9	79.2
Mixed Shrubland	60.4	83.5
Freshwater/Brackish Wetland	21.4	57.0
Natural Watercourse	85.0	64.4
Mangrove	92.5	49.7
Intertidal Mudflat	73.2	86.3
Shrubby Grassland	25.1	34.9
Baeckea Shrubland[g]	38.1	(See Above)
Sandy Shore[h]	96.6	92.1
Rocky Shore[h]	100.0	95.9
Cultivation	80.8	77.2

Note:

f: The habitat was represented as dot locations on the preliminary base map and therefore was not applicable for spatial calculation.

g: Baeckea Shrubland is grouped under Shrubby Grassland in this Study.

h: The habitat (or majority of it) was mapped as a linear component, the total "area" surveyed for the habitat is represented by the length (km) of the habitat.

The mapping accuracy of the surveyed habitats in this Study ranged from 34.9% for Shrubby Grassland to 95.9% for Rocky Shore. High mapping accuracy (>90%) was obtained for Sandy Shore (92.1%) and Rocky Shore (95.9%). Satisfactorily high mapping accuracy percentage (70% - 90%) was obtained for Lowland Forest (79.2%), Mixed Shrubland (83.5%), Intertidal Mudflat (86.3%) and Cultivation (77.2%). Habitats having a moderate mapping accuracy of between 40 - 70% include Freshwater/Brackish Wetland (57.0%), Natural Watercourse (64.4%) and Mangrove (49.7%). Relatively low mapping accuracy (< 40%) was recorded for Shrubby Grassland (34.9%) (*Table 5.26*).

The habitats on the existing habitat map were mapped in the form of polygons (except for the majority of sandy shore, rocky shore and artificial rocky/hard shoreline) with an accuracy level of ± 20 m as required by the Study Brief of the previous Study. The present Study has adopted a similar approach to the previous Study in the selection of survey sites. Locations where habitat type and/or boundary are uncertain and their mapping accuracy is expected to be low have been preferentially chosen for field verification. The present field surveys have provided data to rectify the habitat type and their boundary in order to improve the mapping accuracy of the habitat map as far as possible.

Freshwater and Intertidal Habitats

Similar to the previous Study, the mapping accuracy of the two coastal shore habitats surveyed, ie Sandy Shore and Rocky Shore, was recorded to be high (>90%). This could be attributed to the fact that natural rocky and sandy shores were mapped with a high level of confidence in the previous Study through recourse to manual identification using existing topographic data

(Lands (1997 1:20K) and (1997 1:1K)), aerial photos and the expertise of the SUSDEV21 Study Team [1]. In addition, the habitat areas surveyed in this Study are mainly located in remote areas (see *Figures 5.3i* and *5.3j*) and relatively free from human disturbance (eg urban development), and hence, a change of habitat type due to development is unlikely.

The mapping accuracy of Intertidal Mudflat remained to be within the range of "satisfactorily high accuracy" for both the present and previous Study (*Table 5.26*). The majority of the mis-identified area was actually covered by the mangroves along the landward side of the mudflat. The changes could possibly be attributed to the continual growth and seaward extension of the mangrove habitats (see *Section 5.3.7)*. While it was considered relatively easy to locate the extent of the intertidal mudflat habitat along the coastline, it was difficult to mark the exact boundary of the outermost seaward extent of the mudflats as this was limited by the tidal conditions even though the field surveys were undertaken during low tides.

Mangrove showed a moderate mapping accuracy of 49.7% in this Study which is comparatively lower than the previous Study (*Table 5.26*). The majority of the mis-identified areas were re-classified as Fishpond/Gei Wai. The landward portion of some of the mapped habitats was actually lowland forest or mixed shrubland whereas some areas on the seaward side were re-identified as Intertidal Mudflat. The habitats were mapped in the form of polygons with an accuracy level of ± 20 m (as required by the Study Brief of the previous Study). Field surveys have picked up areas where over-mapping of mangrove habitats had occurred and have thus improved the accuracy of the habitat map.

A much lower mapping accuracy (64.4%) was obtained in this Study for Natural Watercourse than in the previous Study (85.0%) (*Table 5.26*). The majority of the mis-identified watercourses were actually modified watercourse with their riverbanks being channelised with concrete materials. These changes in the habitat type are likely to have occurred after the habitat map was generated and the time when satellite imagery and aerial photos used for the mapping were taken in the previous Study (see *Section 5.3.5*).

The mapping accuracy obtained for wetland is 57.0% and is comparatively higher than the accuracy value (21.4%) calculated in the previous Study (*Table 5.26*). Many of the wetland habitats surveyed were found to be cultivated land and some other areas were actually occupied by other vegetation habitats such as lowland forest, plantation, shrubby grassland and grassland. It was mentioned in the *Final Report* of the previous Study[2] that wetland is difficult to distinguish from inundated grassland and wet vegetation due to spectral similarity. The mis-classification of wetlands to other vegetation habitats recorded during the field surveys conducted for this Study is thought to be due to the spectral proximity of these habitats to wetlands. Some wetlands were found to have changed into urban developed areas and re-classified

(1) ERM-Hong Kong, Ltd (2000) *Op cit.*

(2) ERM-Hong Kong, Ltd (2000) *Op cit.*

under the "Other" category. This change of habitat use might have occurred after the time when satellite imagery and aerial photographs were taken and which were used for the production of the habitat map during the previous Study.

Terrestrial Habitats

Shrubby Grassland (including *Baeckea* Shrubland) showed a percentage accuracy of 34.9% which is comparable to the accuracy percentage values of Shrubby Grassland (25.1%) and *Baeckea* Shrubland (38.1%) obtained in the previous Study (*Table 5.26*). The reason for the seemingly low mapping accuracy obtained for this habitat is mainly due to their intrinsic spectral similarities and the likelihood of these habitats growing intermingled with other vegetation habitats (eg mixed shrubland) which has made mis-identification a rather common phenomenon for this habitat. In addition, the shrubby grassland might have gradually turned into mixed shrubland through gradual natural succession after the time when satellite imagery and aerial photographs were taken during the previous Study (see *Section 5.3.8*).

The other natural vegetation habitats, including Lowland Forest, Mixed Shrubland and Cultivation showed satisfactorily high mapping accuracy percentages (70% - 90%). The majority of the mis-classified habitat areas of these habitats were found to be occupied by other natural vegetation types and have thus been re-categorised into the appropriate habitat class(es). As explained in previous sections (*Sections 5.3.*2, *5.3.3* and *5.3.11*) these habitats are known to be intermingled with other habitats of similar spectral properties and are expected to have a lower than high mapping accuracy.

Accurate mapping of the boundary of some of the natural vegetation habitats during field surveys was found to be difficult as many of the natural vegetation habitats (eg shrubby grassland, mixed shrubland and lowland forest) do not have a well defined boundary between habitat types. In fact, the habitats are often intermingled with each other and the boundary of the categorised habitats is actually represented by a gradual change in the vegetation species composition and the plant forms. Field surveyors made use their expertise and professional judgment to define the boundary of each habitat area they surveyed, for example, by examining the change in species composition, vegetation structure and spatial complexity. Topographic information and other locational features such as houses, footpaths, streams, overhead electrical cables, changes in contour levels of nearby mountains and valleys, as well as the structural complexity of habitats were found useful in helping surveyors to identify the habitat boundary. The colour of the habitat area was also found helpful in distinguishing the habitat boundary for shrubby grassland. The habitat was surveyed mainly during the winter season (December – February) (see *Table 5.18*) when a number of the grass species were flowering and this had facilitated the identification of the extent of the habitat.

It is important to understand that the mapping accuracy presented in *Table 5.26*, calculated based on the results obtained from field surveys, can only be

used to indicate the mapping accuracy of the habitat area surveyed. The data do not reflect the mapping accuracy of the habitat map. It should be noted that using the results from field surveys to establish an overall accuracy for the habitat map is not valid as the sites have not been randomly selected. In many cases the sites have been chosen specifically because discrimination of the particular habitat type during the initial mapping period of the existing habitat map in the previous Study would have been low. In this way the field surveys provided an opportunity to upgrade the accuracy of the habitat map. It is also not feasible nor logical to use the survey results to estimate the mapping accuracy of each habitat category since survey sites have been chosen preferentially on those areas where the mapping accuracy was expected to be low. In addition, the surveys have covered only a small percentage of area for most of the habitat types surveyed (see *Table 5.1*). Therefore, it is not valid to extrapolate the field data to reflect the mapping accuracy of individual habitat types.

With regard to the calculation of the mapping accuracy, it should be noted that there are some limitations on the calculation that surveyors can only assess the percentage of habitat over-estimated, but not under-estimated, at a particular survey site. For example, for a 10 m^2 of cultivation land, 8 m^2 was actually occupied by wetland, the mapping accuracy would be recorded as 20%. However, if the habitat has been under-estimated in the initial mapping, say a 1,000 m^2 lowland forest was mapped as a 500 m^2 lowland forest on the habitat map, the mapping accuracy of that habitat would still be recorded as 100%. The extra habitat area would, however, be marked onto the habitat map to reflect the actual habitat boundary.

5.6 WORK PROGRAMME

The revised work programme for this Study is presented in *Figure 5.6a*. A *Draft Report* to document the preliminary findings was submitted on 12 March 2003. The 200 days of field surveys were completed on 5 April 2003. The *Draft Final Report* with full details on survey results for each habitat category and the *Draft GIS Habitat and Conservation Assessment Maps* were submitted on 6 June 2003 to the Director' s Representative and relevant Departments for comment. This *Final Report* and *Final GIS Habitat and Conservation Assessment Maps* were delivered on 30 June 2003 to address comments of the Director' s Representative and relevant Departments.

6.1 EDITING OF MAPPED AREAS BASED ON FIELD SURVEYS

The field surveying exercise made use of Pocket PC technology for the collection of Survey Site locations and changes to the habitat type being surveyed. These edit masks, described in *Section 5.2,* include polygons identifying:

- additions to the habitat (where the habitat was under classified); or
- deletions (where the habitat was mis/over-classified).

These edit masks were thoroughly checked and then used to update the existing habitat map. A field is created in the final GIS database to indicate where changes have been made to the map as a result of the surveying process. All processing was carried out using the ArcGIS product. The updated habitat map is shown on *Figure 6.1a*.

6.2 AREA AND PERCENTAGE COVER OF HABITAT CATEGORIES

6.2.1 *Previous Study*

A total of 111,711.8 ha were mapped for the terrestrial area (covering all land area above the low tide mark) of Hong Kong in the previous Study (*Table 6.1*). Among the 25 habitat categories mapped on the habitat map, Grassland was the most extensive habitat occupying 26,081.3 ha and constituting the highest percentage land cover (23.4%). The three forest habitats, ie Fung Shui Forest, Montane Forest and Lowland Forest, varied widely in their land cover: 16.3% of the total mapped area was identified as Lowland Forest whilst only 0.10% and 0.05% was mapped as Fung Shui Forest and Montane Forest, respectively. The total area mapped for Mixed Shrubland was 16,477.7 ha and comprised a percentage cover of 14.8% which is comparable to that of lowland forest. The remaining two natural vegetation habitats, ie Shrubby Grassland and *Baeckea* Shrubland, are much less extensive in land cover than mixed shrubland and constituted, respectively, 7.8% and 5.4% of the total terrestrial area. These two vegetation habitats comprised a total of 14,679.7 ha representing 13.2% of the total area. About 180 ha of land area was identified for plantation and comprised 0.16% of the total mapped area.

The land areas identified for the natural aquatic (ie Natural Watercourse and Freshwater/Brackish Wetland) and intertidal (ie Mangrove, Intertidal Mudflat, Sandy Shore and Seagrass Bed) habitats are, in general, small and individual habitats occupied < 1.5% of the total land area. Seagrass beds showed a very limited distribution and occupied 0.04% (ie 41.1 ha) of the total land cover. Artificial or modified water habitats showed a comparatively higher land cover than the natural ones. Fishpond/Gei Wai habitat occupied

a map area of 1,835.7 ha which is 1.6% of the total land area. A total of 2,827.0 ha (ie 2.5%) were mapped for Modified Watercourse.

Cultivation occupied 4,381.0 ha which constituted 3.9% of the total land area. The low value disturbed habitats, such as Golf Course/Urban Park and Quarry, showed a low percentage of coverage < 1.0%. Urban or highly modified area (including buildings), ie Other, was found to be extensive and occupied 16.9% (ie 18,819.9 ha) of the total land area. Other negligible value habitats, ie Landfill and Rural Industrial Storage/Containers, presented much lower percentage cover values of 0.36% and 0.90%.

Changes in habitat areas ranged from 0.01% (Mixed Shrubland) to 594.8% (Plantation or Plantation/Mixed Forest) (*Table 6.1*). Although there was only a small area of plantation mapped using satellite imagery and aerial photos, a considerable area of plantation (about 154 ha) was picked up during field surveys and marked onto the habitat map. For the majority of the habitats the total area has changed only slightly (< 2%).

While a total of about 206.4 ha of sandy shore habitats were mapped as spatial components, the majority of the habitat was represented as a linear component. The coastline of Hong Kong is mainly composed of rocky shore which constituted a percentage length cover of 62.3%. Artificial Rocky/Hard Shoreline showed a total length of 273.2 km and comprised 24.0% of the total shoreline. Sandy Shore showed the lowest percentage length cover, ie 13.7%, and had a total length of 156.4 km.

Table 6.1 ***Area Mapped Before and After Field Surveys and Habitat Verification for Each Habitat Type, their Percentage Change and Final Percentage Cover (Previous Study)***

Type	Pre-Survey Area (ha)	Post-Survey Area (ha)	Percentage Change (%)	Post-survey % Cover
Grassland	26,119.9	26,081.3	-0.15	23.4
Other	18,757.2	18,819.9	+0.33	16.9
Lowland Forest	18,333.4	18,225.4	-0.59	16.3
Mixed Shrubland	16,476.2	16,477.7	+0.01	14.8
Shrubby Grassland	8,695.2	8,702.8	+0.09	7.8
Baeckea Shrubland	6,000.4	5,976.9	-0.39	5.4
Cultivation	4,281.1	4,381.0	+2.3	3.9
Modified Watercourse	2,809.5	2,827.0	+0.62	2.5
Fishpond/Gei Wai	1,892.9	1,835.7	-3.0	1.6
Intertidal Mudflat	1,640.2	1,563.9	-4.7	1.4
Bare Rock or Soil	1,442.3	1,440.0	-0.16	1.3
Freshwater/Brackish Wetland	1,172.4	1,030.5	-12.1	0.92
Rural Industrial Storage/Containers	1,012.2	1,007.7	-0.44	0.90
Golf Course/Urban Park	1,002.3	1,006.7	+0.44	0.90

Type	Pre-Survey Area (ha)	Post-Survey Area (ha)	Percentage Change (%)	Post-survey % Cover
Natural Watercourse	814.3	783.4	-3.8	0.70
Landfill	397.2	397.7	+0.11	0.36
Mangrove	281.3	326.5	+16.1	0.29
Quarry	220.7	228.9	+3.7	0.20
Sandy Shore (spatial)	156.8	206.4	+31.7	0.18
Plantation or Plantation/Mixed Forest	25.9	180.0	+594.8	0.16
Fung Shui Forest[i]	82.3	111.7	+35.7	0.10
Montane Forest	60.4	59.6	-1.3	0.05
Seagrass Bed[i]	26.6	41.1	+54.7	0.04
Rocky Shore[j]	712.2	709.9	-0.33	62.3
Artificial Rocky/Hard Shoreline[i]	276.2	273.2	-1.1	24.0
Sandy Shore (linear)[j]	150.7	156.4	+3.8	13.7
Total (spatial):	111,700.7	111,711.8		
Total (linear):	1139.1	1139.5		

i: Some of the habitat area was mapped as dot locations on the base map.

j: The habitat was mapped as a linear component, the pre- and post-survey "area" is represented by the length (km) of the habitat. (Those sandy shores which have widths greater than 20 m were mapped as polygons (ie spatial in nature)). "Post-survey percentage cover" was calculated based on the length of the habitat relative to the total length of the three linear habitats (ie Rocky Shore, Artificial Rock/Hard Shoreline and Sandy Shore).

6.2.2 *Present Study*

Table 6.2 presents the land cover of each habitat type and the change in areal coverage of each before and after the field surveys conducted for this Study (see *Sections 5.3.1 – 5.3.11*) and the re-classification of habitats based on the desktop review on the latest photographs for Fishpond/Gei Wai (see *Section 5.3.12*) and the AFCD plantation data (see *Section 5.3.13*). The final percentage cover on the revised habitat map is also provided in the Table. The total area mapped on the updated habitat map is 111,697.4 ha which is slightly less than the pre-updated map. This is due to the re-classification of the mapped habitat in Tai Ho Wan to marine areas (Site 15a of Natural Watercourse).

Terrestrial Vegetation Habitats

Among the 24 habitat categories mapped on the revised habitat map, Grassland is still the most extensive habitat (25,752.8 ha) and constituted the highest percentage land cover (23.1%). Lowland Forest and Mixed Shrubland remain to be the second and the third largest natural vegetation habitats identified on the habitat map and occupied 16.0% and 14.9% of the total land cover respectively. With the combination of shrubby grassland and *Baeckea* shrubland, the combined habitat showed a considerable coverage on the habitat map and comprised 13.2% (14,332.1 ha) of the total area. Habitat verification for the present Study has resulted in an addition of 130.6 ha

(0.79%) to Mixed Shrubland but a reduction of 321.0 ha (1.8%) and 346.7 ha (2.4%) from Lowland Forest and Shrubby Grassland (including *Baeckea* Shrubland), respectively (*Table 6.2*). Fung Shui Forest covers a total of 210.7 ha on the revised habitat map with an increase of 88.7% (99.0 ha) coverage after habitat assessment. Habitat verification undertaken for this Study has re-classified a total of 800.5 ha of plantation onto the habitat map. The total areal cover of plantation has increased to 980.5 ha (ie 0.88% of the total land cover). An increase of 69.6 ha (1.6%) was obtained for Cultivation after habitat verification and the habitat area constituted 4.0% (4,450.6 ha) of the total land cover (*Table 6.2*).

Freshwater and Intertidal Habitats

A total of 56.9 ha of mangrove were added onto the habitat map after habitat verification and the habitat comprised 0.34% of the total land cover. Freshwater/Brackish Wetland had a reduction of 100.1 ha (9.7%) in the overall habitat area and the post-survey coverage was 930.4 ha. Natural Watercourse was found to occupy 31.9 ha (4.1%) less than the previous habitat map whereas an extra of 8.1 ha (0.29%) have been re-classified to Modified Watercourse (*Table 6.2*).

Fishpond/Gei Wai and Intertidal Mudflat had their areal coverage reduced by 81.1 ha (4.4%) and 43.3ha (2.8%) respectively after habitat assessment. Minor adjustments to the habitat extent of Sandy Shore and Rocky Shore were made after field verification. A slight increase in both the spatial (4.4 ha) and linear (0.79 km) components of Sandy Shore whereas a decrease of 1.1 km was identified for Rocky Shore (*Table 6.2*).

Disturbed Habitats

As with the previous Study, the "Other" category is still the second most extensive habitat type identified on the habitat map. The present study has recovered a further 97.3 ha of "Other" area from other habitat types and the category occupied a total of 18,917.2 ha (ie 16.9% of total percentage cover).

Table 6.2 ***Area Mapped Before and After Field Surveys and Habitat Verification for Each Habitat Type, their Percentage Change and Final Percentage Cover (This Study)***

Type	Pre-Survey Area (ha)	Post-Survey Area (ha)	Change in Area (ha)	Percentage Change (%)	Post-survey % Cover
Grassland	26,081.3	25,752.8	-328.5	-1.3	23.1
Other	18,819.9	18,917.2	+97.3	+0.52	16.9
Lowland Forest	18,225.4	17,904.4	-321.0	-1.8	16.0
Mixed Shrubland	16,477.7	16,607.1	+129.4	+0.79	14.9
Shrubby Grassland (including *Baeckea* Shrubland	14,679.7	14,332.1	-347.6	-2.4	12.8
Cultivation	4,381.0	4,450.6	+69.6	+1.6	4.0
Modified Watercourse	2,827.0	2,835.1	+8.1	+0.29	2.5

Type	Pre-Survey Area (ha)	Post-Survey Area (ha)	Change in Area (ha)	Percentage Change (%)	Post-survey % Cover
Fishpond/Gei Wai	1,835.7	1,754.6	-81.1	-4.4	1.6
Intertidal Mudflat	1,563.9	1,520.6	-43.3	-2.8	1.4
Bare Rock or Soil	1,440.0	1,431.5	-8.5	-0.59	1.3
Freshwater/Brackish Wetland	1,030.5	930.4	-100.1	-9.7	0.83
Rural Industrial Storage/Containers	1,007.7	1,006.9	-0.80	-0.08	0.90
Golf Course/Urban Park	1,006.7	999.5#	-7.2	-0.72	0.89
Natural Watercourse	783.4	751.5	-31.9	-4.1	0.67
Landfill	397.7	397.7	0.00	0.00	0.36
Mangrove	326.5	383.4	+56.9	+17.4	0.34
Quarry	228.9	217.4	-11.5	-5.0	0.19
Sandy Shore (spatial)	206.4	210.8	+4.4	+2.1	0.19
Plantation or Plantation/Mixed Forest	180.0	980.5	+800.5	+444.7	0.88
Fung Shui Forest[k]	111.7	210.7	+99.0	+88.7	0.19
Montane Forest	59.6	59.6	0.00	0.00	0.05
Seagrass Bed[k]	41.1	43.0	+1.9	+4.6	0.04
Rocky Shore[l]	709.9	708.8	-1.1	-0.15	62.2
Artificial Rocky/Hard Shoreline[l]	273.2	273.0	-0.18	-0.07	24.0
Sandy Shore (linear)[l]	156.4	157.2	+0.79	+0.51	13.8
Total (spatial):	111,711.8	111,697.4			
Total (linear):	1139.5	1139.0			

k: Some of the habitat area was mapped as dot locations on the base map.

l: The habitat was mapped as a linear component, the pre- and post-survey "area" is represented by the length (km) of the habitat. (Those sandy shores which have widths greater than 20 m were mapped as polygons (ie spatial in nature)). "Post-survey percentage cover" was calculated based on the length of the habitat relative to the total length of the three linear habitats (ie Rocky Shore, Artificial Rock/Hard Shoreline and Sandy Shore).

#: The Study Team confirmed from Hong Kong Pro Golf that the Tuen Mun Golf Course (Driving Range) is closed. The area of the driving range was mapped as a golf course on the habitat map under the "Golf Course/Urban Park" category based on Lands Department data (Lands Department 1997 1:20K and 1998 1:20K Countryside Map Series). As the area is no longer a golf course, it was re-classified under the "Other" category and an indicative ecological value of negligible was assigned.

6.3 *HABITAT POLYGONS DEVELOPED ON THE HABITAT MAP*

6.3.1 *Previous Study*

There are a total of 89,504 habitat polygons identified on the habitat map generated in the previous Study (*Table 6.3*). The number of polygons derived for individual habitat types ranged widely from 12 for Seagrass Bed to 15,370 for Grassland. The majority of other vegetation habitats (except for Fung Shui Forest, Montane Forest and Plantation or Plantation/Mixed Forest) had their polygon numbers > 8,000. Enormous variation in the size of individual polygons was noted for all habitat types. The smallest difference in polygon size, 10^2 times (ie the largest polygon is 10^2 times the smallest one), was recorded for Seagrass Bed whilst the biggest difference was observed for Intertidal Mudflat (ie 10^{11} times). Landfill showed the largest mean polygon

size (26.5 ± 40.5 ha) and there is only one other category, ie Modified Watercourse, which had its mean polygon size > 15 ha. The majority of the other habitat types showed a mean polygon size of < 3 ha. Standard deviation is particularly high for Grassland, Other and Intertidal Mudflat which showed at least 13 times the mean and almost ten times for Lowland Forest and Mangrove.

The large number of polygons identified for the natural vegetation habitats, including Grassland, Lowland Forest, Mixed Shrubland and *Baeckea* Shrubland, and the generally small average size of polygons suggested that the habitats are largely patchy and fragmented in distribution. The relatively low number of polygons (< 50) mapped for Seagrass Bed, Quarry and Landfill indicated that these habitats are of limited distribution in Hong Kong.

Table 6.3 Mean, Minimum and Maximum Area of Polygon Mapped for Each Habitat Type and Their Total Numbers Identified on the Habitat Map (Previous Study)

Habitat Category	No. of Polygons	Total Area (ha)	Minimum Area of Polygon (10^{-4}ha)	Maximum Area of Polygon (ha)	Mean Area of Polygon (ha)	Standard Deviation (ha)
Grassland	15,370	26,081.3	0.01	1979.1	1.7	22.8
Other	8,921	18,819.9	0.67	4771.4	2.1	59.4
Lowland Forest	8,082	18,225.4	0.63	1016.5	2.3	21.6
Mixed Shrubland	19,062	16,477.7	0.004	484.1	0.86	5.9
Shrubby Grassland	10,734	8,702.8	0.04	108.5	0.81	3.5
Baeckea Shrubland	10,616	5,976.9	0.35	120.4	0.5	2.7
Cultivation	4,572	4,381.0	0.01	63.7	0.96	3.0
Modified Watercourse	186	2,827.0	102.1	1201.0	15.2	101.6
Fishpond/Gei Wai	2,281	1,835.7	0.07	61.1	0.80	2.1
Intertidal Mudflat	710	1,563.9	0.00001	722.1	2.2	29.7
Bare Rock or Soil	3,228	1,440.0	0.60	37.5	0.45	1.4
Freshwater/Brackish Wetland	1,556	1,030.5	0.07	32.4	0.66	1.8
Rural Industrial Storage/Containers	1,859	1,007.7	107.9	17.8	0.54	1.2
Golf Course/Urban Park	187	1,006.7	246.4	170.2	5.4	17.3
Natural Watercourse	1,564	783.4	1.3	30.4	0.50	1.4
Landfill	15	397.7	450.8	126.7	26.5	40.5
Mangrove	201	326.5	132.3	220.7	1.6	15.6
Quarry	27	228.9	269.3	60.8	8.5	16.1
Sandy Shore (spatial)	145	206.4	428.1	24.6	1.4	2.8
Plantation or Plantation/Mixed Forest	67	180.0	131.7	44.6	2.7	7.9
Fung Shui Forest	42	111.7	352.2	11.9	2.7	2.8
Montane Forest	67	59.6	152.2	12.4	0.8	1.8
Seagrass Bed	12	41.1	446.1	14.9	3.4	5.0
Total:	89,504	111,711.9				

Note: As Rocky Shore, Artificial Rocky/Hard Shoreline and the majority of Sandy Shore habitats are represented as a linear component on the habitat map, spatial calculation for these habitats was not applicable.

6.3.2 *Present Study*

The existing habitat map was updated based on the results obtained from the field surveys undertaken for this Study. The polygon data on the updated habitat map are summarised in *Table 6.4*.

The updated habitat map contains a total of 98,331 polygons, which is 8,827 more than the pre-updated map. The increase in the number of habitat polygons is a normal consequence of the editing made to the habitat map based on the field survey results and the AFCD plantation data. The union process of map editing which involved intersecting polygons has resulted a higher number of habitat polygons for the edited habitat type.

As with the previous Study, the number of polygons derived for individual habitat types ranged widely among the habitat types. It varied from 14 for Seagrass Bed to 21,367 for Shrubby Grassland (including *Baeckea* Shrubland). The other vegetation habitats such as Mixed Shrubland and Grassland showed a high number of polygons (>15,000) on the habitat map.

Similar to the previous Study, the size of individual polygons varied enormously for all habitat types. The greatest variation was recorded for Other (±57.6 ha) and Natural Watercourse showed the smallest variation (±0.87 ha). Landfill is still the habitat of largest mean polygon size (26.5 ± 40.5 ha). Natural Watercourse had the smallest mean polygon size of 0.29 ± 0.87 ha. The majority of the other habitat types showed a mean polygon size of < 3 ha.

Similar to the previous Study, the number of polygons identified for the natural vegetation habitats, including Shrubby Grassland (including *Baeckea* Shrubland), Lowland Forest and Mixed Shrubland and the generally small average size of polygons suggested that the habitats are largely patchy and fragmented in distribution. The relatively low number of polygons (< 50) mapped for Seagrass Bed, Quarry and Landfill indicated that these habitats are of limited distribution in Hong Kong.

Table 6.4 Mean, Minimum and Maximum Area of Polygon Mapped for Each Habitat Type and Their Total Numbers Identified on the Habitat Map (This Study)

Habitat Category	No. of Polygons	Total Area (ha)	Minimum Area of Polygon (10^{-4}ha)	Maximum Area of Polygon (ha)	Mean Area of Polygon (ha)	Standard Deviation (ha)
Grassland	15,535	25,752.8	0.02×10^{-4}	1,869.4	1.7	21.9
Other (Urban or Other Highly Modified Area)	9,490	18,917.2	0.16×10^{-4}	4,771.4	2.0	57.6
Lowland Forest	8,860	17,904.4	0.11×10^{-4}	914.9	2.0	18.7
Mixed Shrubland	19,638	16,607.1	0.30×10^{-4}	484.1	0.85	5.7
Shrubby Grassland (including *Baeckea* Shrubland)	21,367	14,332.1	3.5×10^{-4}	120.4	0.61	3.1
Cultivation	5,748	4,450.6	0.02×10^{-4}	63.7	0.77	2.7

Habitat Category	No. of Polygons	Total Area (ha)	Minimum Area of Polygon (10^{-4}ha)	Maximum Area of Polygon (ha)	Mean Area of Polygon (ha)	Standard Deviation (ha)
Modified Watercourse	610	2,835.1	$0.20x10^{-4}$	1,201.0	4.7	56.5
Fishpond/Gei Wai	2,189	1,754.6	0.014	61.0	0.80	2.1
Intertidal Mudflat	1,066	1,520.6	$0.13x10^{-4}$	708.7	1.4	23.8
Bare Rock or Soil	3,240	1,431.5	0.068	37.5	0.44	1.4
Rural Industrial Storage/Containers	1,862	1,006.9	0.015	17.8	0.54	1.2
Golf Course/Urban Park	186	999.5	246.4	170.2	5.4	17.3
Freshwater/Brackish Wetland	1,961	930.4	$0.10x10^{-4}$	29.4	0.47	1.4
Natural Watercourse	2,574	751.5	$0.07x10^{-4}$	16.2	0.29	0.87
Plantation or Plantation/Mixed Forest	1,745	980.5	$1.8x10^{-4}$	87.9	0.56	3.0
Landfill	15	397.7	450.8	126.7	26.5	40.5
Mangrove	1,239	383.4	$0.02x10^{-4}$	190.9	0.31	5.5
Quarry	25	217.4	269.3	60.8	8.7	16.6
Fung Shui Forest	480	210.7	0.005	13.3	0.44	1.2
Sandy Shore	420	210.8	$2.2x10^{-4}$	23.4	0.49	1.7
Montane Forest	67	59.6	152.2	12.4	0.89	1.8
Seagrass Bed	14	43.0	0.92	14.9	3.1	4.7
Total:	98,331	111,697.4				

Note: As Rocky Shore, Artificial Rocky/Hard Shoreline and the majority of Sandy Shore habitats are represented as a linear component on the habitat map, spatial calculation for these habitats was not applicable.

6.4 *CONSERVATION ASSESSMENT*

As indicated in *Section 2*, the objective of the conservation ranking system devised for the previous Study was to provide a means by which conservation values of different areas, representing different features, can be ascribed, mapped and compared. The system has incorporated four components, including ecological, heritage, recreation and landscape.

It was confirmed in the *Topic Report* for this Study [1] that the indicative ecological value classifications assigned to each of the mapped habitat categories would be maintained as in the previous Study and no modification to the indicative designation was considered necessary. These ecological value classifications had been refined through the ecological field surveys undertaken in the previous Study and were further refined through the field assessment conducted for this Study. The conservation assessment map was updated based on the field survey results and is presented on *Figure 6.4a*.

[1] ERM-Hong Kong Ltd (2002) *Op cit*.

6.4.1 *Ecological Value of Spatial Habitats*

Previous Study

In the previous Study, there were 40,095.0 ha of habitats classified as of high ecological value which represented 35.9% of the total mapped area (*Table 6.5*). Among these "high" value areas, a total of 11.7 ha of habitats were considered as possessing "unique feature(s)" and thus deserved the designation of an asterisk "*" (ie graded as high*) (see *Annex I* of *Final Report* of the previous Study[1]). "Medium" value habitats comprised 19,926.2 ha (ie 17.8%) of the total land area mapped for Hong Kong. "Unique feature" was also identified in one of these medium-value habitats and an ecological value of medium* was assigned (see *Annex I* of *Final Report* of the previous Study[2]). "Low" and "negligible" value habitats comprised, respectively, 28.2% and 18.1% of the total land cover (*Table 6.5*).

Table 6.5 Total Area of Spatial Habitats Assigned Ecological Value of High*, High, Medium*, Medium, Low and Negligible

Ecological Value	Total Area (ha) (Previous Study)	Percentage Cover (%) (Previous Study)	Total Area (ha) (This Study)	Percentage Cover (%) (This Study)
High*	11.7	0.01	174.4	0.16
High	40,083.3	35.9	39,639.1	35.5
Medium*	0.13	0.0001	13.9	0.012
Medium	19,926.1	17.8	20,404.0	18.3
Low	31,466.5	28.2	31,194.5	27.9
Negligible	20,224.1	18.1	20,271.6	18.1

Present Study

After field assessment for the present Study and habitat verification based on desktop review on aerial photographs for Fishpond/Gei Wai and AFCD plantation data, the total habitat area that was classified as of high ecological value comprised 39,813.5 ha (ie 35.6%) which is 281.5 ha less than the area identified in the previous Study (*Table 6.5*). Among these "high" value areas, a total of 174.4 ha of habitats were identified as areas with "unique feature(s)" and an asterisk "*" was assigned to the habitat. The high ecological value habitats that have been identified as having unique feature(s) during the field surveys for this Study include lowland forests, wetlands, natural watercourses, intertidal mudflats and mangroves (see *Annex D*). Habitat area with a "high*" ecological value on the updated conservation assessment map is comparatively more extensive than the pre-updated map.

A total of 20,417.9 ha (ie 18.3%) of the total land area were identified as of "medium" ecological value of which 13.9 ha were considered as possessing a

(1) ERM-Hong Kong Ltd (2000) Study on Sustainable Development for the 21st Century: Environmental Baseline Survey on Terrestrial Habitat Mapping and Ranking Based on Conservation Value – Annex. Final Report to Planning Department, August 2000.

(2) ERM-Hong Kong Ltd (2000) *Ibid*.

"unique feature(s)" (*Table 6.5*). The habitat categories that were classified as of medium* ecological value in this Study included sandy shore and rocky shore (see *Annex D*). Habitats with a medium ecological value showed a higher coverage on the conservation assessment map than in the previous Study. The areal coverage obtained for the "low" and "negligible" value habitats in this Study was 27.9% and 18.1%, respectively, which are broadly similar to that recorded in the previous Study, (ie 28.2% and 18.1%) (*Table 6.5*).

6.4.2 Spatial Habitats of High Ecological Value

The type of spatial habitats that were ranked as of high (including high*) ecological value is presented in *Table 6.6*. The habitats are largely similar to those identified in the previous Study and are mainly composed of forest and shrubland habitats (including fung shui forest, montane forest, lowland forest and mixed shrubland), inland water habitats (including Freshwater/Brackish Wetland, Fishpond/Gei Wai and Natural Watercourse) and coastal habitats (including Mangrove, Intertidal Mudflat and Seagrass Bed). Small areas of Cultivation, Grassland, Shrubby Grassland, Plantation or Plantation/Mixed Forest and Urban Park have also been identified as high ecological value habitats.

Table 6.6 Type of Spatial Habitats Ranked as of High Ecological Value

Habitat Type	Area (ha) (Previous Study)	% Cover (Previous Study)	Area (ha) (This Study)	%Cover (This Study)
Lowland Forest	18,219.0	16.3	17,898.2	16.0
Mixed Shrubland	16,467.6	14.7	16,568.9	14.8
Intertidal Mudflat	1,537.5	1.4	1,494.8	1.3
Fishpond/Gei Wai	1,278.3	1.1	1,249.3	1.1
Freshwater/Brackish Wetland	1,024.9	0.92	913.2	0.82
Natural Watercourse	737.6	0.66	704.7	0.63
Mangrove	321.2	0.29	374.8	0.34
Fung Shui Forest	111.5	0.10	210.5	0.19
Grassland	86.1	0.08	86.1	0.08
Cultivation	73.6	0.07	73.5	0.07
Plantation or Plantation/Mixed Forest	61.9	0.06	61.9	0.06
Montane Forest	59.6	0.05	59.6	0.05
Seagrass Bed	41.1	0.04	43.0	0.04
Golf Course/Urban Park	34.5	0.03	34.5	0.03
Shrubby Grassland	21.8	0.02	33.0	0.03
Baeckea Shrubland	11.3	0.01	(See Above)	
Sandy Shore	4.7	<0.01	4.7	<0.01
Bare Rock or Soil	2.8	<0.01	2.8	<0.01
Total:	40,095.0	35.9	39,813.5	35.6

6.4.3 *Ecological Value of Linear Habitats*

As with the previous Study, the majority of the linear shoreline habitats (75.8%) were classified as of medium ecological value (*Table 6.7*). A total of approximately 28 km (2.5% of total coastline) of these linear habitats were identified as possessing a unique feature(s) and deserved the designation of an "*" (see *Annex D*). There is no change in the total length of the shore habitats that were ranked as of high and high* ecological value, ie 3 km, when compared to the previous Study. A total of 274.1 km (24.0%) were ranked as of low ecological value (*Table 6.7*).

Table 6.7 Total Length of Linear Habitats Receiving Ecological Value of High*, High, Medium*, Medium and Low

Ecological Value	Total Length (km) (Previous Study)	% Length Cover (Previous Study)	Total Length (km) (Previous Study	% Length Cover (This Study)
High*	1.0	0.09	1.0	0.09
High	2.0	0.17	2.0	0.17
Medium*	17.1	1.5	28.0	2.5
Medium	845.7	74.2	834.3	73.2
Low	273.7	24.0	274.1	24.0

6.4.4 *Linear Habitats of High Ecological Value*

The linear habitats ranked as of high (including high*) ecological value are presented in *Table 6.8*. High value coastline comprised 2.1 km of Sandy Shore and 0.84 km of Rocky Shore. There was no change to the total length of high ecological value shore habitats and the results are the same as the previous Study. The rankings of the linear habitats are shown on *Figure 6.4a*.

Table 6.8 Linear Habitats Ranked as of High Ecological Value

Habitat Type	Total Length (km) (Previous Study)	% Length Cover (Previous Study)	Total Length (km) (This Study)	% Length Cover (This Study)
Sandy Shore	2.1	0.19	2.1	0.19
Rocky Shore	0.84	0.07	0.84	0.07
Total:	3.0	0.26	3.0	0.26

This *Final Report* has presented the results of a review of the previous habitat mapping exercise conducted as part of the SUSDEV 21 Study with details on the discrepancies, uncertainties and outstanding information gaps identified. The report also presents the key findings of the 200 days of ecological field surveys conducted during the period from 29 November 2002 to 5 April 2003 for the present Study. Discussions on finalised definitions of habitat mapping categories, conservation ranking system, strategy of survey effort allocation, survey methodology and the information gaps filled by this Study are also included in this Report. The key findings of this Study are summarised below:

- The definitions of individual habitat mapping categories have been reviewed and it was considered appropriate to revise the definition of Shrubby Grassland to include *Baeckea* Shrubland (see *Section 2*). Indicative ecological value (ie high, medium, low and negligible) of individual habitat types defined in the previous Study is unchanged and no modification was considered necessary.

- It was considered appropriate to retain the conservation ranking system devised in the previous Study to provide an accepted, composite means by which the conservation values of different areas, representing different features, can be ascribed, mapped and compared.

- Ecological field surveys for this Study commenced on 29 November 2002 and were completed on 5 April 2003. A total of 1,189 sub-sites comprising approximately 2,930 hectares of spatial habitats and 49 km of linear habitats were visited during this Study. Field surveys were conducted in accordance with the approved methodology (*Section 4* of this Report).

- The results of the 200 days of field surveys have been used to adjust the mapped boundaries of habitats at particular sites and to upgrade or downgrade the indicative ecological value assigned on the basis of the criteria presented in *Section 2*. The data collected from the field surveys have been analysed and used for editing the existing habitat map and refining the ecological value ranking.

- Ecological field assessment has shown that there are habitats, which are considered as of high intrinsic conservation value (with an indicative high ecological value) (including Freshwater/Brackish Wetland and Natural Watercourse), that appear to have been severely affected by pollution (eg sewage pollution) and thus have been downgraded to a lower ecological value (medium or low). However, it should be noted that ecological value of these affected habitats could be considered for upgrading once the adverse influences are dealt with (and perhaps remedial measures taken). These survey sites may be re-visited in the future to re-assess their existing

ecological conditions and provide data to justify the suitability of re-adjusting these habitats to a higher ecological value.

- The updated habitat map comprised a total of 98,331 habitat polygons and a total land cover (above low tide mark) of 111,697.4 hectares. Among the 24 habitat categories mapped on the habitat map, Grassland is the most extensive habitat whilst Seagrass Bed occupied the smallest land cover.

- The mapping accuracy of the surveyed sites based on field surveys ranged from 34.9% to 95.9%. High mapping accuracy (>90%) was obtained for Sandy Shore (91.5%) and Rocky Shore (95.9%). Satisfactorily high mapping accuracy percentage (70% - 90%) was obtained for Lowland Forest (79.2%), Mixed Shrubland (83.5%), Intertidal Mudflat (86.3%) and Cultivation (77.2%). Habitats having a moderate mapping accuracy of between 40 - 70% included Freshwater/Brackish Wetland (57.0%), Natural Watercourse (64.4%) and Mangrove (49.7%). Comparatively low mapping accuracy (< 40%) was recorded for Shrubby Grassland (34.9%).

- A total of 39,813.5 hectares of habitats, representing 35.6% of total land cover, were classified as of high ecological value after habitat verification for this Study. Of these high ecological value habitats, 174.4 hectares were identified as possessing a unique feature(s) and deserved the designation of an "*". A total of 20,417.9 hectares (ie 18.3%) of the total land area were identified as of medium ecological value with 13.9 hectares of them being considered as possessing a "unique feature(s)". The areal coverage obtained for the low and negligible value habitats in this Study was 27.9% and 18.1%, respectively.

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