CHAPTER 1

PROGRAMME DEFINITION AND BASELINE DATA ACQUISITION

Introduction:

If coastal zone management is to be practicable and effective, the limits of the management unit must be defined clearly. The manager must know what he is concerned with in geographical terms, but appreciate also existing institutional responsibilities. Opinions differ regarding the seaward and landward **limits of the coastal zone** (United Nations, 1982) and these are a major concern of the United Nations Convention on the Law of the Sea (UNCLOS, 1982). However, some authors question the validity of the concept when applied to island situations (OTA, 1987). Most continental countries possess coastal areas which differ and are clearly separated from the hinterland, in so far as their geomorphology and socioeconomic activities are determined largely by marine influences. Many of the smaller, low islands, such as the Bahamas, are dominated throughout by the sea and for planning purposes "island management" is a more realistic concept. Where large islands or high islands are concerned, whether these are volcanic, raised limestone or continental in origin, lines of separation can be drawn between the terrestrial, coastal and oceanic zones under national jurisdiction. Once the coastal zone is defined, a programme for its management is required.

Knowledge of the **system to be managed** is of critical importance to formulation of an effective management programme. Information is available normally from published sources, maps and photographs, unpublished reports, expert and popular knowledge, although it must be interpreted and related to the situation under study. Where it is inadequate or needs updating, standard techniques can be used by the coastal manager to improve the **data base.** Once this is done the data must be accessible to the planner or manager, who will most likely want to involve government agency officials and resource users in the final formulation and execution of the coastal zone management programme. Various means of **mapping baseline data** are available and can make the task of baseline data acquisition and utilisation much easier. This chapter is concerned with some of these simple, but fundamental, aspects of management.

Exercise 1.1 DEFINING THE SCOPE OF A COASTAL ZONE MANAGEMENT PROGRAMME

Background:

Any programme of coastal zone management will be concerned with a specific zone of the island. It will differ in character or objectives from management programmes for other parts of the country and, ideally, it will require a coastal zone management authority or special committee to direct it. For planning purposes these distinctions are important, as they determine **what, where and who** will be involved in the programme.

Several choices are available in making these distinctions. One could, for example, include only the immediate intertidal area of the sea coast in the coastal zone. Then shipping, beaches and natural ecosystems extending up to the high tide level, such as mangrove swamps, would be managed by a special authority. Such a narrow definition would be unsatisfactory on the grounds that shipping uses the oceans also and receives cargo from the hinterland, beaches are nourished by land-derived sediment, and mangroves are influenced normally by riverine inputs and marine organisms. For effective management of natural intertidal systems, all associated coastal plain and drainage-catchment areas would need to be included in the coastal zone and watershed management would become an essential part of the coastal zone management process. Furthermore, this limit excludes characteristic, and important, coastal habitats like coral reefs, seagrass beds and the subtidal regions of bays, estuaries and lagoons, which would then need a separate marine authority to manage them.

One alternative would be to concentrate not on cartographic limits, but on the regulation of activities which are specific to the coastal zone. This approach would identify as coastal zone management concerns all shipping, the major part of an island's fishing, core activities in tourism and recreation, domestic and industrial waste disposal, and marine park development. A criticism would be that no one of these activities is confined 100% to the coastal zone, in either geographic or socioeconomic terms. Also, the relevant institutions may not for example administer marine parks separately from other aspects of conservation or sea-based tourism in isolation from inland activities.

Nonetheless, there is no doubt that certain activities are fundamentally **coastal**, like tropical island tourism, and, as such, merit special treatment. Several natural ecosystems are rarely found elsewhere. There are also

some problems which are characteristically coastal zone problems, such as beach erosion, oil pollution , marine fouling and fishery resource depletion, and these require a specialist approach to their solution. Coastal zone managers could restrict themselves to solving these problems, but even here it would be essential to define limits and institutional responsibilities. For example, loss of a valuable tourist beach through erosion may have been caused by human activities at a distant location (see Bacon & Head, 1985) or through-on site construction work which did not conform to controls placed on it by the central planning agency (St.Croix Avis, 1987). Its solution may lie in management of a whole stretch of coastline, or simply in attention to enforcement of regulations. Similarly, overexploitation of a reef fishery may have resulted from increase in the number of fishermen following decline in the agriculture sector; so its solution lies ultimately with the ministry responsible for employment, or in shifting effort to other areas such as tourism or mariculture. Overexploitation is seen then as a socioeconomic issue, rather than one needing fisheries biology or natural resource management skills; although these may be called upon at a later stage when attempting to resuscitate the damaged fishery.

It is important, therefore, when embarking on coastal zone management, both generally and in specific problem situations, to establish clearly the **scope** and **issues** involved, the **linkages** within and external to the situation, and the level of legal and **institutional responsibility.**

Aim:

To establish the scope of a Coastal Zone Management Programme.

Objectives:

To define the boundaries of a Coastal Zone Sector.
To identify the Coastal Zone management issues in this sector.
To rank the issues in order of importance.
To identify agency responsibility in the Coastal Zone sector.

Duration:

One day. Half day fieldwork; half day drawing office.

Suitable Location:

A natural area of island coast, preferably containing established industrial or tourism development; or the main

port area; or a large town based on a bay or lagoon; or an area of intensive natural resource utilization.

Materials Required:

Topographic map sheets (1:50,000 or larger scale depending on chosen site) - one per student, or per group.
Bathymetric charts.
Aerial photographs 1:12,500 or larger scale.
Data sources (as appropriate) for:

- Baseline geography and natural ecosystems
- Historic development changes
- Socioeconomic features (population, fishing, commerce, factory products etc.)
- Tourism sector (visitor numbers, linkages etc.)
- Government or other agency responsibility

Instructions:

Preliminary investigations.

1. Maps, charts and aerial photographs should be examined prior to the field visit, so that students are familiar with the geography of the area selected. (See also Exercise 1.2)

2. A series of sites should be pre-selected for field visitation. There should be about 10 of these to include all significant natural and man-made features of the area that can be examined during a half-day period.

Field methods

3. At each study site the following observations should be recorded:

   (a) The precise location (marked on the map).
   (b) Types of natural ecosystems, human activities or infrastructure (e.g. mangroves, fishing, loading cargo).
   (c) Area of coastline occupied by each feature or activity.
   (d) Reason why each activity, or piece of infrastructure, occurs there.
   (e) General statement on contribution of each activity to the economy (i.e. no. of jobs created, type of service provided).
   (f) Activities in adjacent areas.

(g) Any problems caused by each activity, or by adjacent activities.
(h) Any problems which hinder any of the above activities.
(i) Agency which regulates each activity, or controls infrastructure.

(When travelling between study sites, notes can be made on other types of activities observed.)

Analysis

4. On return to the drawing office/laboratory, field observations should be analysed as follows:

(a) Select broad usage categories for the area of coastal zone studied (e.g. Recreation; Fishing; Transport).
(b) List all activities observed under the appropriate usage category. Beside each activity indicate, in parentheses, how it is related to the coastal zone, e.g. Power station (seawater used for cooling).
(c) Estimate the percentage of the coastline occupied by each category. Rank these percentages in descending order.
(d) Rank the categories in order of their relative contribution to the island's economy. Compare this order with that given in (c).
(e) Link each identified activity with its responsible agency. List these concerned agencies under each category heading. (N.B. An agency may appear in more than one category).
(f) Identify areas of conflict between observed activities in the coastal zone.
(g) Identify the agencies responsible for reducing these conflicts.
(h) Suggest any activities external to the immediate coastal area studied that influence the activities listed in (b).
(i) List any agencies other than those listed in (e) and (g) with responsibility for items mentioned in (h).

Product

The analysis can be prepared in the form of maps, tables and linkage diagrams. These should be similar to those shown in Figure 1.1 and Tables 1.1-1.3, which are the results of a **Case Study** on the Kingston Harbour coastal zone, Jamaica, conducted in 1986.

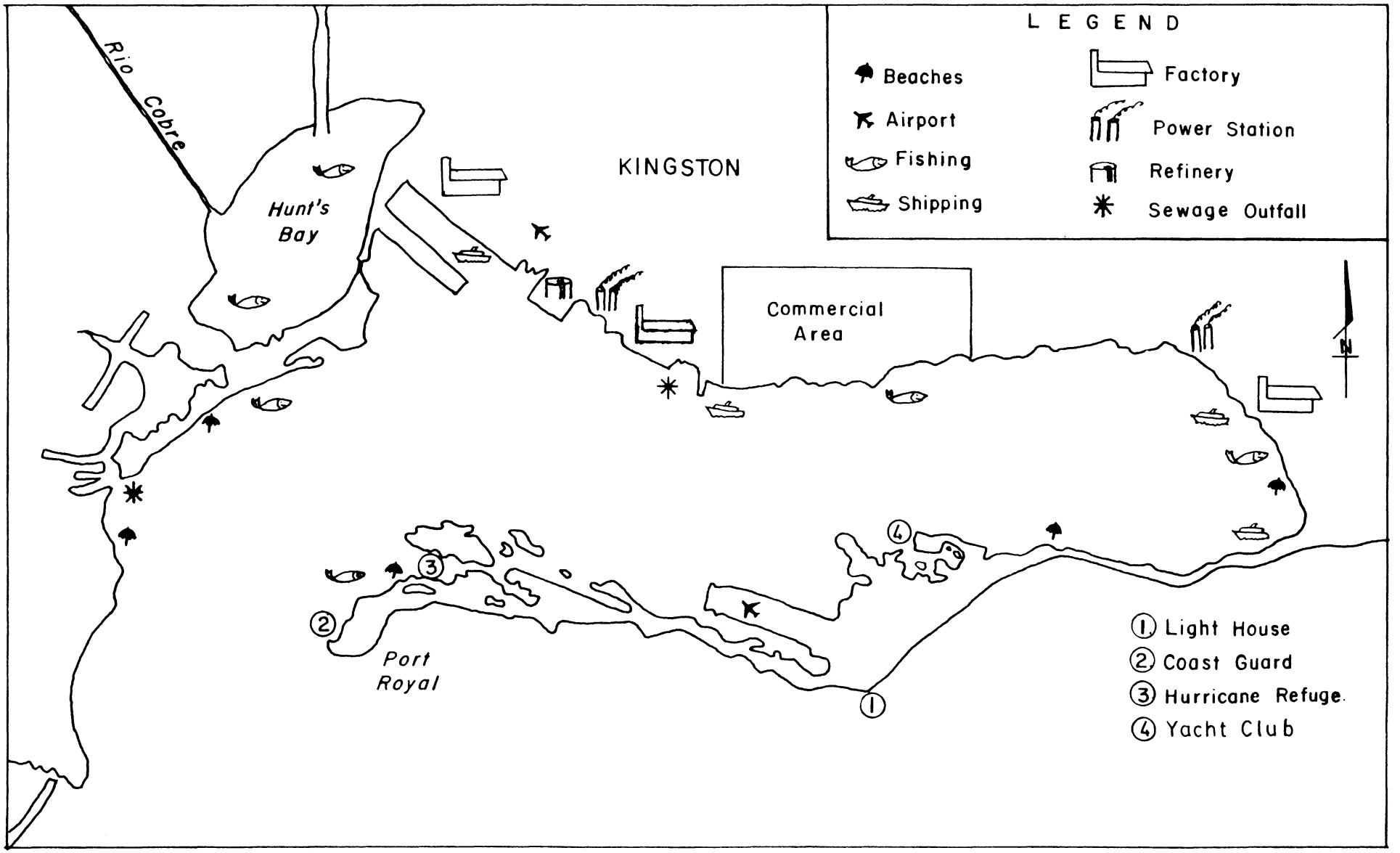

FIGURE 1.1 COASTAL LAND-USE: KINGSTON HARBOUR

Table 1.1 Percentage land use of the Kingston Harbour Coastal Area

Activity	% of Harbour coast
Shipping	20
Commerce	17
Recreation	15
Transport (roads, airports)	15
Forestry (timber, charcoal)	12
Manufacturing	10
Fishing	9
Waste disposal	2

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Table 1.2 Contribution to the National Economy of Activities in the Kingston Harbour Coastal Area

Activity	% contribution
Shipping	45
Manufacturing	20
Commerce	10
Transport	9
Waste disposal	7
Recreation	5
Fishing	3
Forestry	1

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Table 1.3 Some Institutions involved in the Management of the Kingston Harbour Coastal Zone (modified from Chow, 1987).

Institution	Area of Responsibility
1. Jamaica Defence Force/ Coast Guard	Control of oil spills
2. Jamaica Public Service Co.	Power generation (sea water cooled station)
3. Ministry of Agriculture	
Fisheries Division	Fisheries management
Forestry Division	Mangrove area management
Natural Resources Conservation Division	Natural areas management, environmental regulation
4. Ministry of Construction	
Office of Disaster Preparedness	Contingency planning for natural hazards
5. Ministry of Health	
Environmental Control Division	Water quality (health) management, pollution control and cleanup
6. Office of the Harbour Master	Maritime activity control
7. Petroleum Corporation of Jamaica	Petroleum shipments
8. Tourist Board	Recreational areas and cruise ship docking
9. Town & Country Planning Department	Kingston Metropolitan area planning control
10. Urban Development Corporation	Development & planning

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This should be followed by group discussion which attempts to define a practicable Coastal Zone Management Unit based on the study area. Key aspects for consideration are:

5. What activities are directly dependent on or influenced by resources or features of the coastal zone?

6. Are these activities located in a clearly defined zone?

7. How large an area to seaward or landward of this zone must be managed to support or safeguard activities within the zone?

8. What resources are critical to development within the zone ?

9. What are the major issues in this zone that require management:

   - to ensure continued resource use,
   - to reduce damage to resources and maintain quality of life in this zone,
   - to reduce conflict between users ?

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Alternative Exercises

(1) This assessment can be carried out on a <u>whole island basis</u>, given a small, little developed island, or a longer period of time with the larger island.

(2) In some cases a <u>specific development site</u> would be appropriate (see Ex. 2.2).

(3) An extension to any of the above exercises could be an investigation of <u>legal provisions for Coastal Zone Management</u> at a study site. This should be in the form of a critical survey of existing and required legislation enabling coastal management. This would include analysis of component clauses in environmental laws and agency involvement (see Ex. 3.6).

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Further Reading:

Armstrong, J., Bissell, H., Davenport, R. et al, 1974. Coastal Zone Management: the Process of Program Development. Coastal Zone Management Institute, Sandwich, Massachusetts, USA; 152 pages.

Brahtz, J.F.P. 1972. Coastal Zone Management; Multiple Use with Conservation. John Wiley, New York, 352 pages.

Cambers, G. 1985. An Overview of Coastal Zone Management in Six East Caribbean Islands. UNESCO Regional Office for Science & Technology for Latin America and the Caribbean, Montevideo, 69 pages.

Commonwealth Science Council 1987. Coastal Zone Management of the Caribbean Region: a Status Report. Commonwealth Science Council Technical Report, 227; 188 pages.

United Nations 1982. Coastal Area Management and Development, United Nations Department of International Economic and Social Affairs, Ocean Economics and Technology Branch, Pergamon Press, Oxford, 188 pages.

USDC 1987. Caribbean Marine Resources, Opportunities for Economic Development and Management. US Department of Commerce, Washington, D.C.; 91 pages.

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Exercise 1.2 INTERPRETING COASTAL FEATURES FROM AERIAL PHOTOGRAPHS

Background:

Aerial photography is particularly useful when investigating areas which are poorly mapped or with difficult access, such as coral reefs and wetlands. Photographs can be used effectively to gain an impression of the general geography of an area prior to the commencement of field investigations. But, more importantly, many types of quantitative information not normally shown on maps can be read off photographs, e.g. dimensions of trees in a mangrove forest or density of plants in a seagrass bed. Aerial photographs frequently provide information about temporary natural phenomena, such as wave patterns and river flood outfall plumes, or about short term human activities such as numbers of fishing boats or holiday makers in a particular location and directions of waste-water effluent streams.

Most countries have aerial photographs taken at intervals over many years and these series provide some of the most useful information for coastal managers. Tropical island coastal zones are dynamic features and photographs of an area taken in different years can show beach erosion or accretion, development of mangrove swamps, structural changes of coral reefs, as well as the spread of industry, harbour facilities or resort real estate. Study of these changes can be used in the analysis of long-term trends in coastal zone development or environmental degradation, as well as being a reminder that the coastal ecosystems which we attempt to manage are evolving and being modified continuously by natural forces.

Aerial photography can be particularly useful, therefore, for aiding the description and inventory of coastal resources and for documenting changes in coastal ecosystems and human impacts. This exercise is concerned with **photo interpretation**, as a technique in coastal management. It is based on the use of standard vertical aerial photographs.

Aerial photographs are used extensively for modern cartography and the process of photogrammetry is discussed in relation to the preparation of Data Atlases in Ex 4.2.

Aerial photography is only one technique in the rapidly advancing field of remote sensing. Some types of satellite imagery are very sophisticated and can provide information about coastal zone phenomena on a regular basis. However, as Klemas (1984) points out, air photos are still preferable for certain components of the coastal zone, such as coastal geomorphology, erosion, vegetation and

land use (Table 1.4). They are also cost effective, easily obtainable and analysable without specialised training or equipment. Furthermore, there is a much longer historical record available for coastal zones in a national air photos archives than there is in any of the satellite imagery data centres.

Aim:

To identify images in a coastal zone aerial photograph.
To measure the sizes of selected objects identified on photographs.

Duration:

Half day drawing office/laboratory work, half day field work.

Suitable locations:

Determined by available aerial photographs

Materials Required:

Set of aerial photographs (stereoscopic pairs).

Availability of aerial photographs varies from island to island, according to government regulations. Photographs can be obtained in most countries from the Surveys Department or the Defence Forces. If photographs cannot be purchased, it is possible normally to get permission to examine them at the archives, even if this means holding the training session there by prior arrangement.

Stereoscope (loan from Surveys Department or college Geography Department).
Straight edge.
Overlay - transparent acetate sheets.
Drawing equipment.
Topographic maps sheets (same area, same scale).

Instructions:

Introduction to aerial photographs

1. Prepare a mosaic of the group of photographs by overlaying these roughly. Study this to get an overview of the whole area.

2. Select an individual photograph and study this with the naked eye.

Table 1.4. Performance of some aircraft and satellite remote sensing for coastal studies (modified from Klemas, 1984)

	Film Cameras		Multispectral Scanners		Thermal IR Scanners		Imaging Radar (SAR or SLAR)	
	AC	SC	AC	SC	AC	SC	AC	SC
Vegetation & Land Use	3	2	3	2	1	0	2	1
Biomass & Veg. Stress	1	1	2	1	1	0	1	0
Coastline Erosion	3	2	3	2	1	0	3	2
Coastal Geomorphology	3	2	3	2	0	0	3	2
Depth Profiles	2	1	2	2	0	0	1	1
Susp. Sediment Patterns	2	2	3	3	1	1	1	0
Susp. Sediment Concentration	1	1	2+	2	0	0	0	0
Chlorophyll Concentration	1	1	2+	2	0	0	0	0
Oil Slicks	2	1	3	2	3	1	3	2
Surface Temperature	0	0	0	0	3	3	1	0
Water Salinity	0	0	0	0	1	0	1	0
Current Circulation Patterns	2	2	2	2	2	2	2	1
Wave Spectra	2	2	2	2	0	0	3	2

Rating
3 = Reliable (Operational)
2 = Needs additional field testing
1 = Limited value (Future potential)
0 = Not applicable

Platform
AC = Aircraft (medium or low altitude)
SC = Spacecraft (satellite)

3. Locate on the map sheet the area covered by the photograph.

4. Locate on the photograph the main features shown on the map. Note their appearance (Figure 1.2).

5. Cover the photograph with a transparent overlay sheet. This should be attached on one side only to permit inspection of the photograph. The outlines of features of interest should be traced with pencil, ink or marker and labelled clearly.

6. Compare your tracing with the accompanying map sheet. What information have you recorded which was not represented on the map?

7. Select five or six objects clearly shown on the aerial photograph and mark their location on both your tracing sheet and the map sheet. These should be objects which are accessible in the field from roads, paths or along the sea front, are likely to be recognisable in the field and whose dimensions can be easily measured. Some suggested objects are

   (a) A sandspit across a river mouth
   (b) A low cliff
   (c) A stand of trees (thought to be mangroves)
   (d) A sea wall
   (e) A building

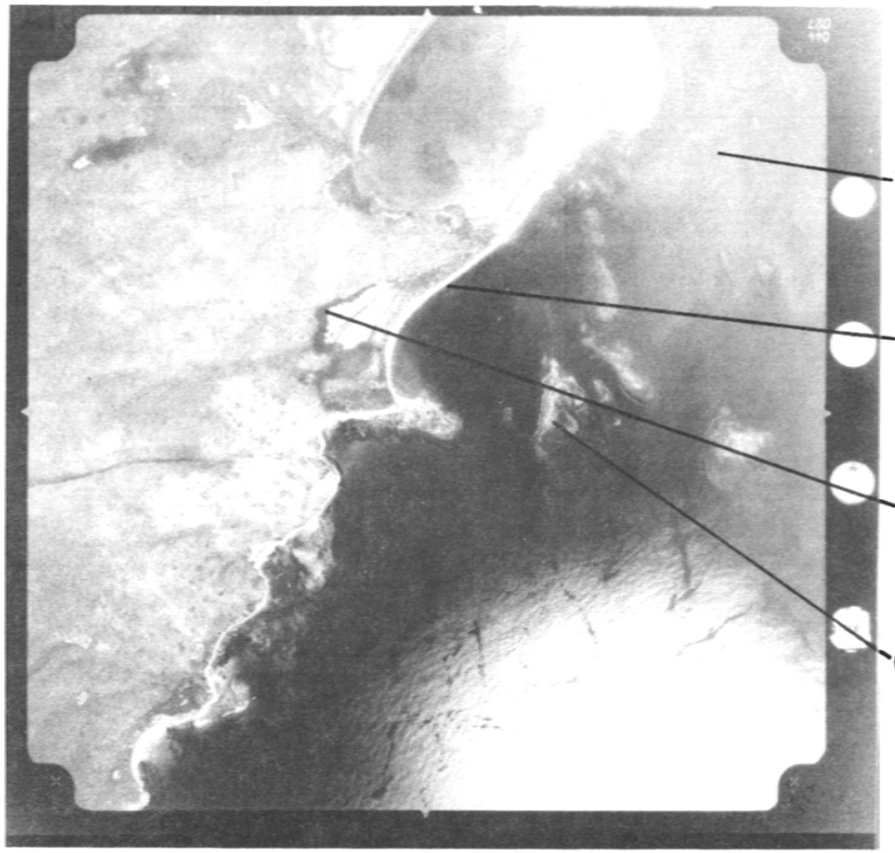
   Estimate the horizontal dimensions of the objects by reference to your photograph and map scales.

8. Visit the area shown on the photograph. Locate and examine the objects selected. Measure their horizontal dimension in order to "ground truth" your photo interpretation.

9. Measure or estimate the vertical height of as many of the selected objects as possible. Keep these measurements for use on return to the drawing office/laboratory.

Stereoscopic pairs

10. Examine each of a pair of aerial photographs in turn. Unless otherwise indicated, north is normally at the top of the photograph. Other information given includes the print identification number, date, time of day, altitude of the plane, and focal length of the camera, as shown in Figure 1.3. Locate these features.



Aids to Identification

TONE	TEXTURE	PATTERN	SITE
light	reflecting or rippled		
light	smooth	crescent or ribbon shaped	bay
dark	granular	rounded	fringing
grey	patchy	scalloped	inshore

FIGURE 1.2 APPEARANCE OF SOME COASTAL FEATURES ON AERIAL PHOTOGRAPHS

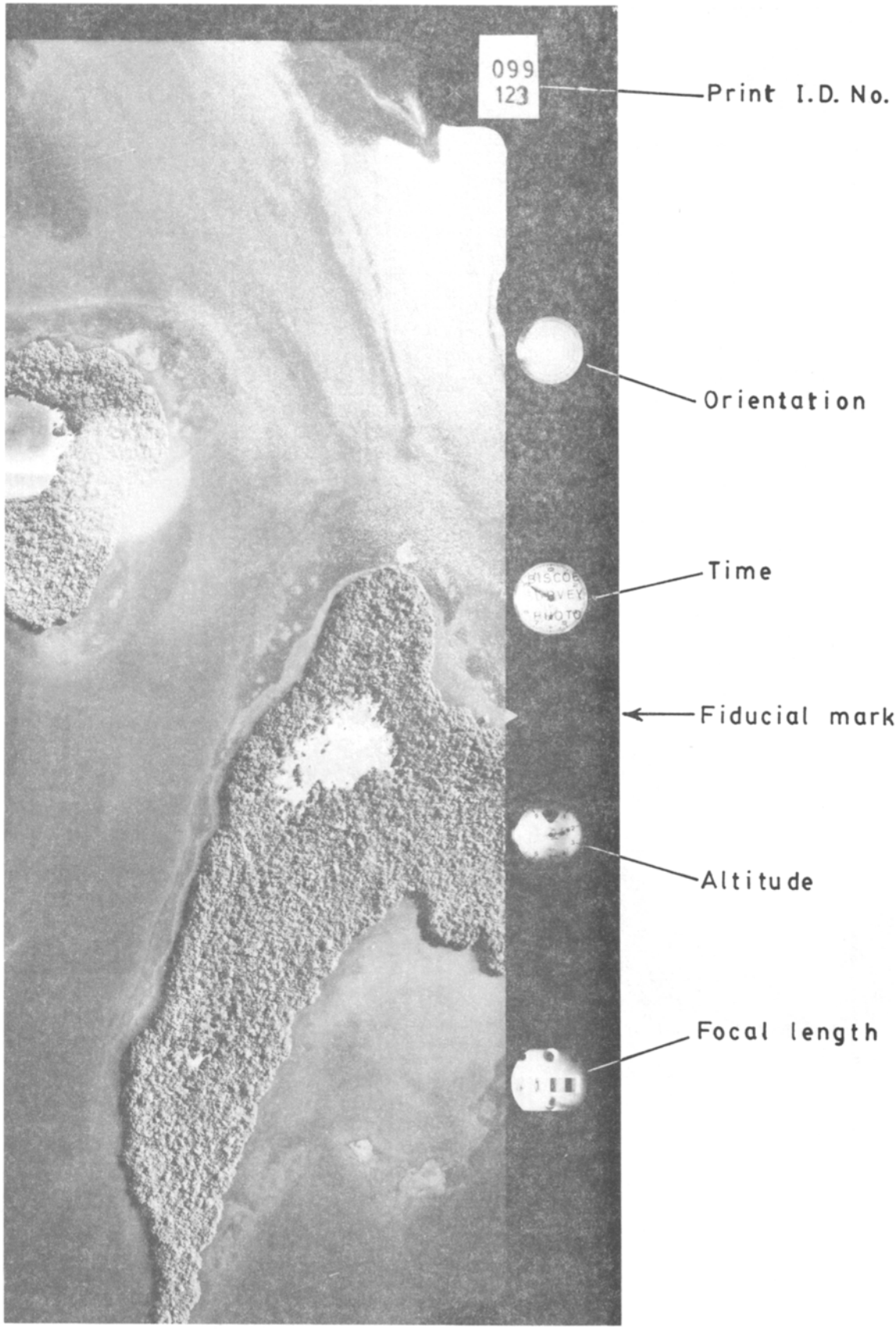


FIGURE I.3 COMPONENTS OF AERIAL PHOTOGRAPHS

11. Calculate the scale of the photograph, according to the following

$$\frac{\text{Camera focal length}}{\text{Altitude}} = \text{general scale}$$

Check this against the scale reported when the photographs were obtained. Note that this calculation is influenced by fluctuations in altitude of the plane during survey work, and is thus an approximation.

12. Locate the Principal Point on each photograph (Figure 1.4a). Mark the P.P. with ink or a pin hole.

13. Locate and mark on each photograph the image of the overlapping photograph's P.P. (Figure 1.4a). These secondary points are called Conjugate Principal Points.

14. Draw a line through the P.P. and C.P.P on each photograph. The line represents the flight path of the plane.

15. Overlap the photographs on a bench top so that the images match, flight lines superimpose, and the combined flight line lies from left to right (Figure 1.4b).

16. Slide the photographs laterally to separate them the distance of your eyes, about 5-6 cms. Place a stereoscope above the junction between the two photographs. Adjust the photographs and the stereoscope until a three-dimensional effect is achieved.

17. Examine the stereoscopic pair of photographs.

18. Refer to the field observations made under 9 above (vertical heights of selected objects). Locate these objects on the photograph and view them stereoscopically. Note their three-dimensional appearance and compare this with your records of size and elevation.

19. Use the stereoscope to measure the horizontal extent and vertical height of the selected objects. Check this against the field data.

Note: It is important to stress that the coastal manager need not restrict interpretive study to the standard government photographs. Aerial photographs taken

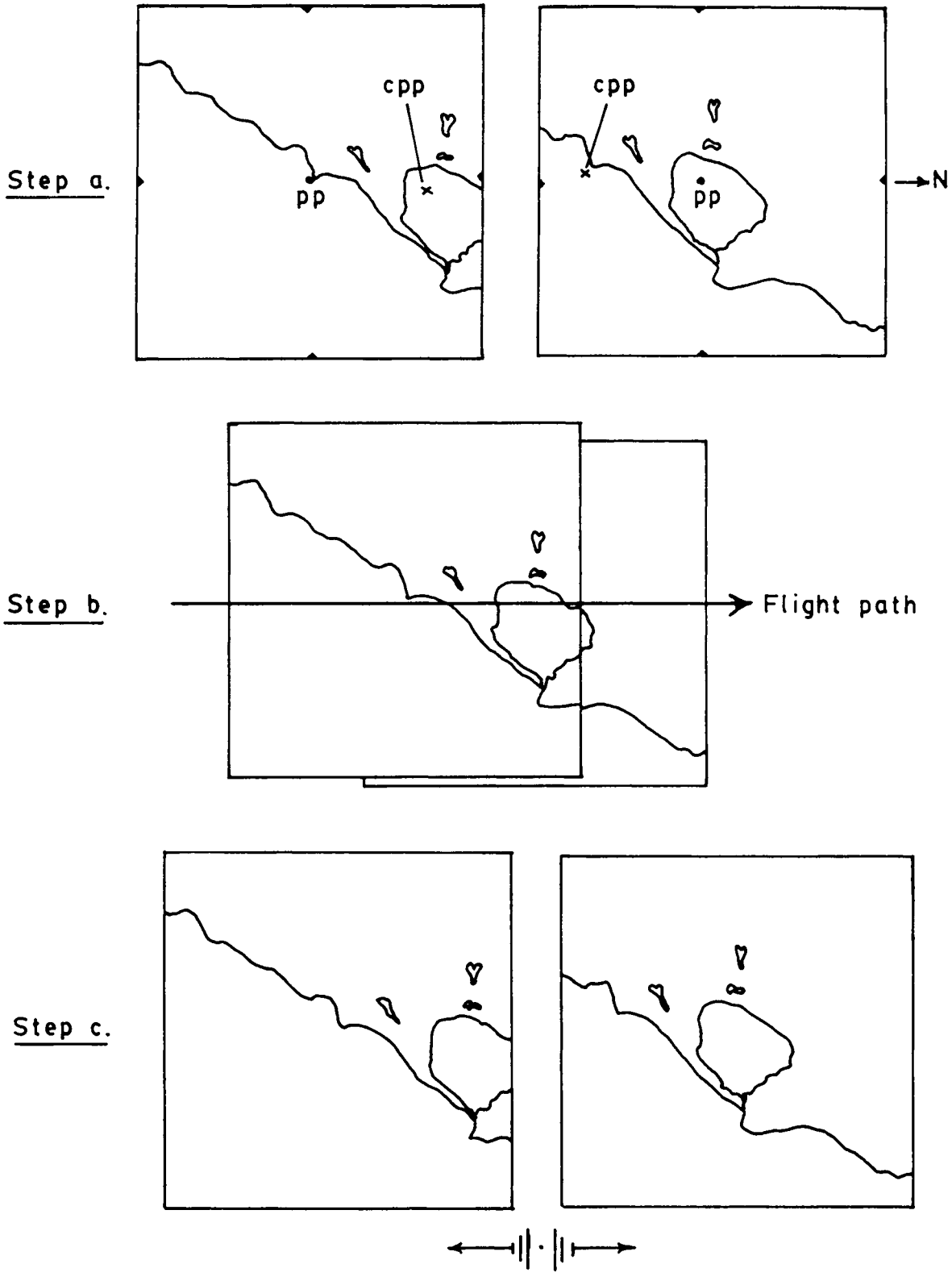


FIGURE 1.4 ORIENTATION OF AERIAL PHOTOGRAPHS FOR STEREOSCOPIC VIEWING

personally using a hand-held camera can be of tremendous value (Figure 1.5), particularly for short-lived events like flood run-off, or wave refraction patterns (see Exercise 2.2.). Aerial surveying from light aircraft is relatively cheap and yields abundant, high quality information once an observer gains some experience (see Appendix 2).

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Alternative Exercises:

1. Study the **changes** which have taken place in a selected coastal area over a period of five or ten years. Obtain and study two sets of photographs, taken at the start and end of the time period (and other sets taken in between, if available). Suitable subjects for study would be:

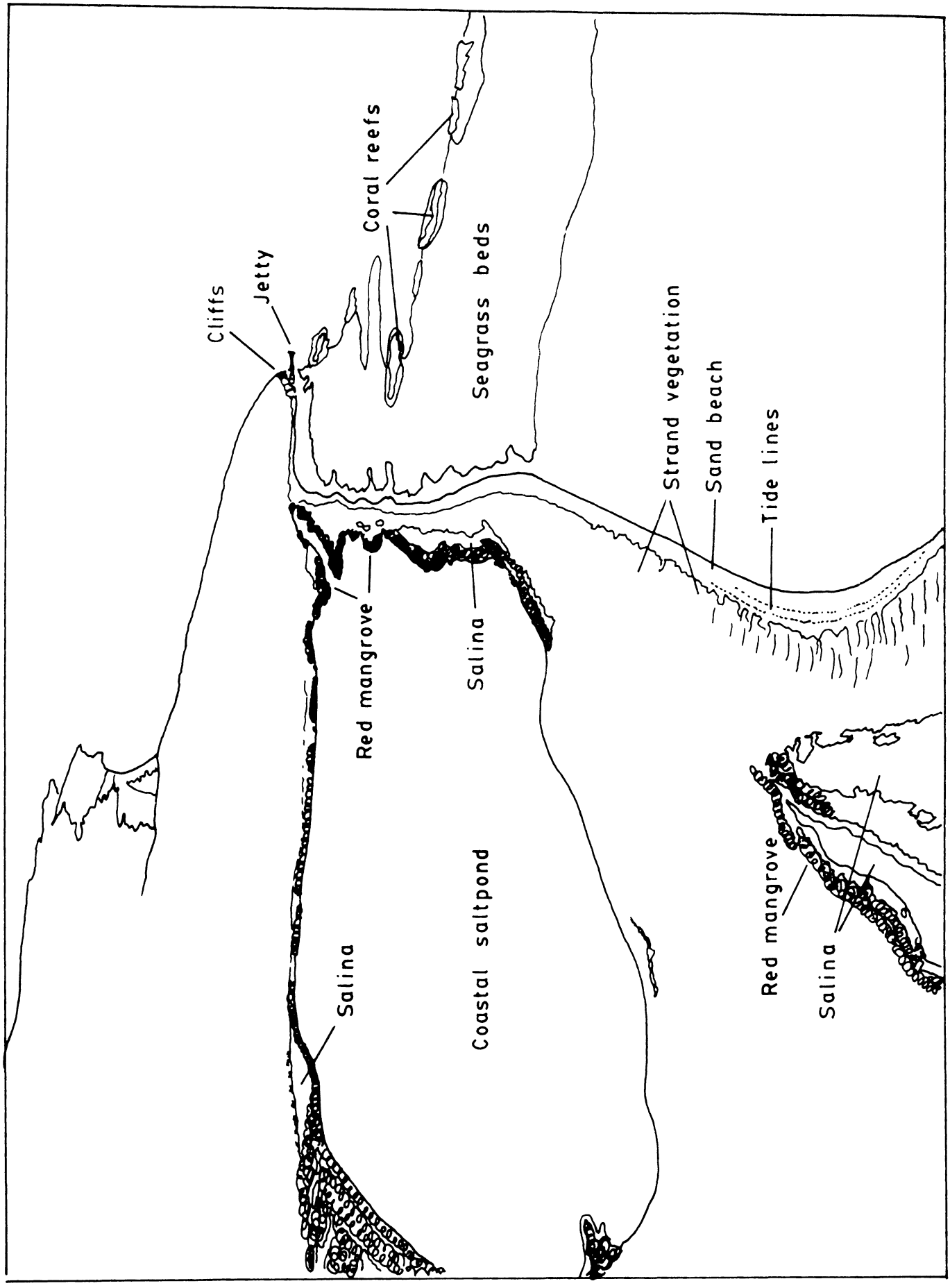
   a. the increase in coastal development
   b. vegetation changes resulting from reclamation in a coastal wetland
   c. extent of erosion of a beach
   d. growth or change in position of a lagoonal sandbar

2. Construction and interpretation of a photo-mosaic. This is an extension from the study of individual or stereoscopic pairs of photographs, to building a composite photo picture of a wider area. Obtain two identical sets of six to ten aerial photographs of a coastal area for which there is good map coverage. Use the following two methods of placing these together in a "mosaic":

   a. fit the edges of one set of photographs together by cutting around clear images (such as rivers, roads, forest margins).
   b. fit the other set of photographs together using fixed map points and measured distances, i.e. select two features on the accompanying map and measure the distance between them; locate these features on adjacent photographs and join the photographs so that the features are the equivalent distance apart; repeat this with features on all other pairs of adjacent photographs until the mosaic is complete.

      Compare the overall picture formed by the mosaic using the two methods. Because there will be some perspective displacement, compare the distances

FIGURE 1.5 OBLIQUE AERIAL PHOTOGRAPH (HAND HELD CAMERA) AND ITS INTERPRETATION (see opposite)



See photograph opposite

between fixed points on both mosaics with those given on the maps.

Further Reading

Sabins, F.F. 1978. Remote Sensing: Principles and nterpretation. W.H. Freeman & Co., San Francisco; 426 pages.

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Exercise 1.3 MAPPING COASTAL FEATURES FOR MANAGEMENT PURPOSES

Background:

The accurate inventory and description of coastal features, such as natural ecosystems or human land-use, is essential before management decisions can be made or problems solved. The characteristics, areal extent and general distribution of features of interest can be recorded in a variety of ways, but visual presentation in the form of maps, charts or diagrams frequently makes interpretation easier. Although general maps, particularly topographic sheets, are likely to be available in most tropical island states, the coastal zone manager will be interested in specific information. To aid management decision making, it may be advantageous to produce new maps showing only certain types of information appropriate to the current problem situation. Furthermore, where maps of the study area are not available, or are not at a large enough scale, or the information is contained only in aerial photographs (see Exercise 1.2), a mapping project will be necessary.

Before mapping can commence, it is essential to decide on the **purpose** of the map or maps; i.e. what do you need to show in order to satisfy the project goals? There are several choices; for example, features and information can be distinguished on a map:

- simply by name, e.g. "beach", "seagrass bed", "hotel", (**Nominal System**).
- by being ranked to show differences between them, e.g. to distinguish a major recreational beach from a minor one (**Ordinal System**).
- by a scaling which shows the interval between ranks, as is done with contours and bathymetry, or by relating differences to a standard unit, e.g. number of hotels per square kilometer, (**Interval System**).

In all cases, appropriate **symbols** should be used to highlight the important characteristics of the information which the manager requires. Bearing these requirements in mind throughout the mapping exercise helps to avoid the temptation to include superfluous information, and produces clear, subject-oriented maps which are easy to use.

The following exercise, and accompanying case study, are concerned with coastal mapping of areas with inadequate cartographic representation of the ecosystems being studied. (Reference should be made to Exercise 3.3 which

includes mapping work associated with the production of Data Atlases; although that exercise is based on already existing maps and data sets). They relate to preliminary investigations of coastal ecosystems, such as those which might be required prior to permitting coastal development (see Chapter 2), establishing a protected area (see Chapter 3), or regulating resource exploitation (see Chapter 4). In each case it is necessary to record what systems are present, how these are distributed, and how they are structured. This information may need to be presented to a range of agency personnel with differing technical expertise and, thus, should be clear and readily decipherable.

Aim:

To produce maps characterising the ecosystems of part of the island coast.

Objectives:

a. To show the location and areal extent of the different ecosystems in the study area.
b. To rank the ecosystems in order of importance.

Suitable Location:

A coastal area, of not more than one square kilometer, which contains a variety of features, e.g. beach, lagoon & fringing reef.

Materials Required:

Transparent Acetate sheets
Blank maps
Stereoscope or desk magnifier
Drawing equipment
Transect lines - 30 to 50 m long, marked at 1 m intervals
Compass
Surveying poles

Instructions:

Preliminary Laboratory/Drawing Office Work

1. As a group, decide precisely what type of information is required.

2. Select main system categories which will be mapped, e.g. reef, wetland, littoral woodland.

3. Define each main category, and write this out so that

the group knows the characters and limits of each mapping category.

4. Select and define the sub-categories to be mapped, e.g.

Main Category	**Sub-Category**
Wetland	Rhizophora zone
	Avicennia zone
	Water channel
	etc.

N.B. If data is to be obtained from aerial photographs these sub-categories must be recognisable.

5. Select an appropriate scale for the maps. This should permit representation of the smallest areas of all sub-categories in relation to the required map sheet size.

6. Prepare base maps on which to enter survey data. The map sheets should show outlines of some landmark features, such as headlands, and the compass bearing. It may be useful to trace a grid onto the base maps as a guide to data entry, or to divide the area into sectors in relation to topographic, bathymetric or habitat features. Place a scale on the map; and leave a space for the Legend.

7. If aerial photographs are to be used, overlay these with acetate sheets on a light table and trace (a) topographic or bathymetric features, (b) outlines of the main systems, and then (c) outlines of the sub-systems. Ground-truth this information by a field survey of the study site (as described below).

Field Measurements

8. If aerial photographs are not available, conduct a field survey of the study site. Begin this by testing observer reliability, i.e. confirm that all members of the survey team agree on how to recognise all mapping categories and on what symbols to use on the field maps. To do this, all team members should survey a common area, and compare notes. The team leader should eradicate discrepancies, and estimate the percentage reliability of forthcoming observations.

9. Commence mapping using marked lines, or tape measures, to determine the boundaries between adjacent system categories. The lines should be placed along a regular grid oriented by using a compass. At

intervals on the shore, and frequently when using a boat in the bay or lagoon, determine the location of key data points. This is done most easily by the process of triangulation, i.e. by taking the compass bearings of two clearly visible landmarks and recording these; calculating the angle and drawing a line from each landmark; and fixing the position where the two lines intersect.

Analysis of Field Data

10. On return to the laboratory/drawing office, plot the fixed positions on the base maps and then plot horizontal and line transect data in relation to these points.

11. Having traced outlines which show the boundaries between adjacent system categories, place symbols within these boundaries to show clearly the location and relative distribution of the categories.

12. Once the map or maps are drawn, complete the mapping exercise and analysis as follows:

    (a) Assign an Importance Value.

    The coastal manager/decision-maker will need to be guided by some indication of "important" features in the study area. Depending on the specific issue being investigated, this can be indicated most easily by some form of ranking of the systems. This could be in order of areal coverage, frequency of occurrence, relative economic value or sensitivity to some stressor. As a group discuss the relative importance of the features mapped.

    (b) Summary Statement concerning the Study Area.

    From the field notes, prepared maps and suggested importance values, prepare a brief statement which summarises the general features of the study site.

Product

The mapping exercise should produce materials similar to those shown in Figures 1.6 & 1.7 and Table 1.5; which are taken from surveys conducted in the Virgin Islands (Anderson, et al, 1986; Beets, et al, 1986) and include vertical transect data intended to show the structure of

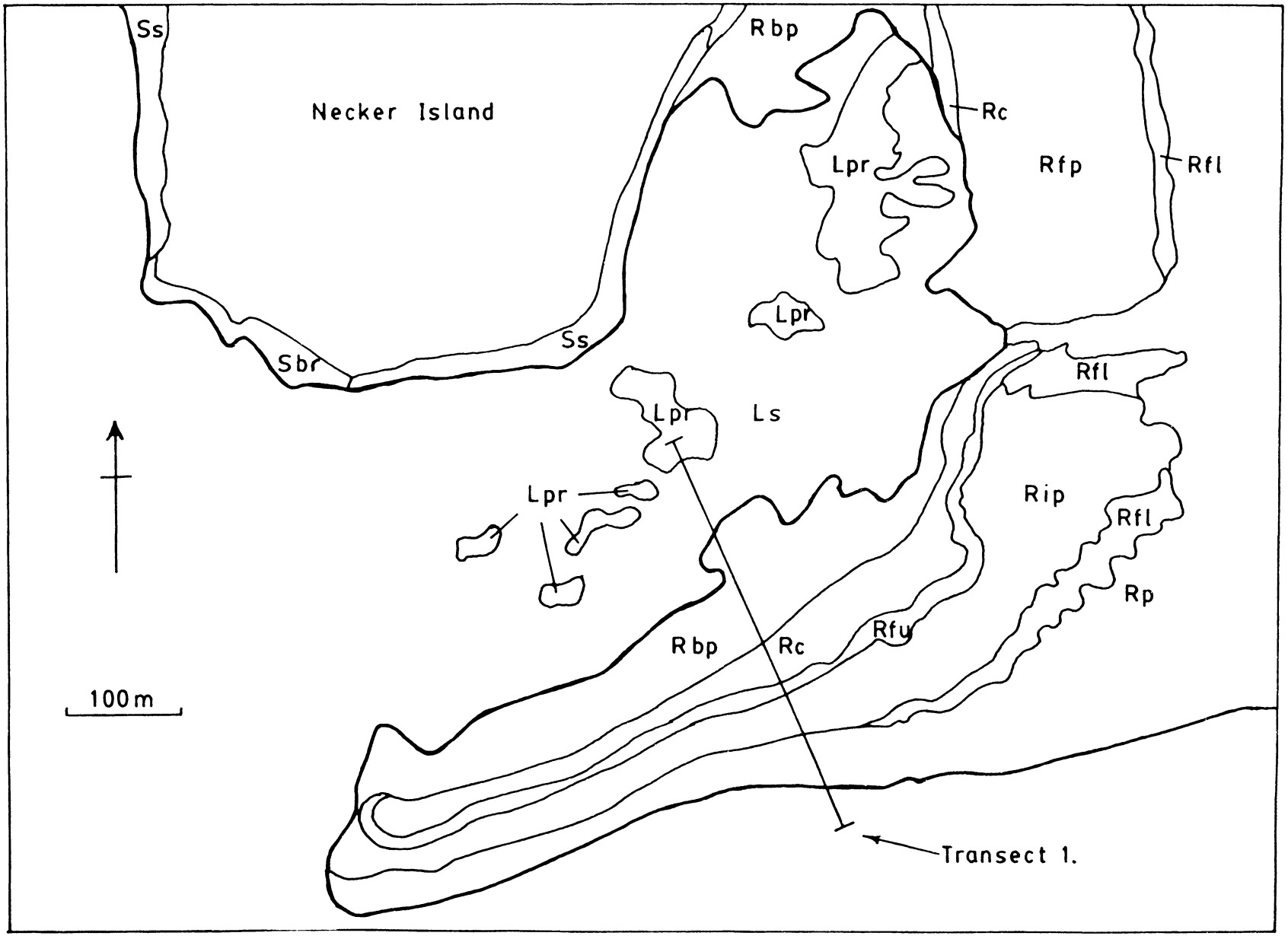

FIGURE 1.6 COMMUNITY DISTRIBUTION MAP - NECKER ISLAND
(for symbols and transect see Table 1.5 and Figure 1.7)

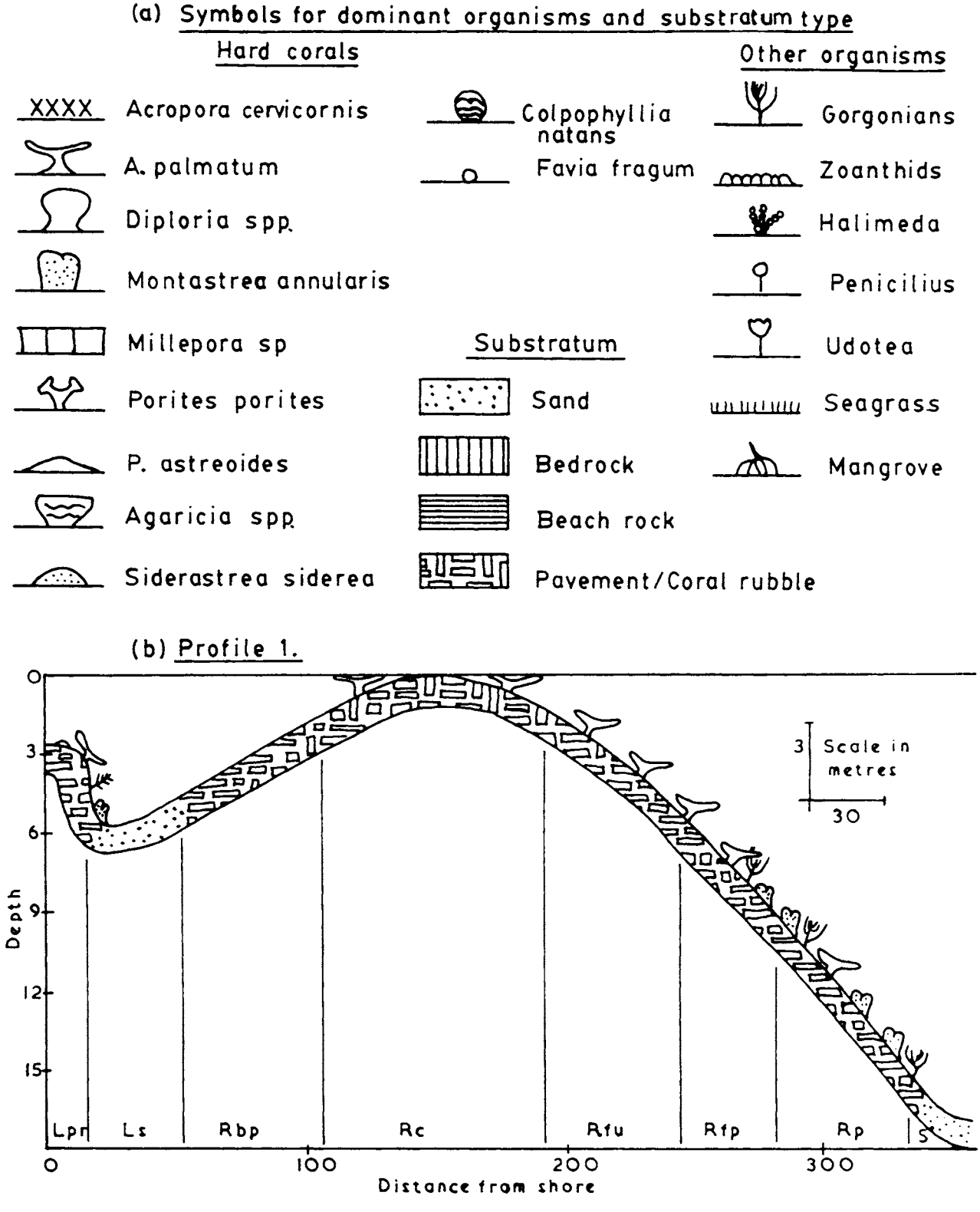

FIGURE 1.7 COMMUNITY MAPPING: (a)SYMBOLS, (b)TRANSECT PROFILE

Table 1.5 Example of Zone & Subzone Designations for Mapping of Coastal Ecosystem Features
(Source: Anderson et al, 1985)

Zone and Subzone	Designation
A. Shore Zone	S
1. Beach rock	Sb
2. Sand	Ss
3. Mangrove	Sm
4. Pavement	Sp
5. Gravel/cobble	Sg
6. Bedrock	Sbr
B. Subtidal Bedrock Zone	SR
C. Lagoon	L
1. Sand	Ls
2. Pavement	Lp
3. Seagrass bed	Lg
4. Patch reef	Lpr
(a)pavement	Lprp
5. Fringing reef	Lf
D. Shallow Bay Zone	SB
1. Sand	SBs
2. Pavement	SBp
3. Seagrass bed	SBg
4. Patch reef	SBpr
5. Mud	SBm
6. Algae	SBa
7. Fringing reef	SBf
E. Reef Zone (fringing & barrier)	R
1. Backreef	Rb
(a) head coral/grotto	Rbh/Rbg
(b) pavement	Rbp
2. Reef crest	Rc
3. Forereef	Rf
(a) upper (arborescent)	Rfu
(b) lower (massive)	Rfl
(c) pavement	Rfp
4. Sand	Rs
5. Gorgonian reef	Rgo
6. Pavement	Rp

Substrate Cover Type	Designation
Live hard coral	HC
Dead coral	DC
Gorgonian coral	Go
Zoanthids	Z
Macroalgae	A
Mangrove	Sm
Seagrass	G
Pavement/turf	T
Sand	S
Shore bedrock/cobble	Sbr
Beachrock	Sb

the coral reefs. Figure 1.7a shows examples of the types of symbols which can be used for dominant organism in the Caribbean; use of a few of which is demonstrated in profile 1 in Figure 1.7b.

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Alternative Exercises:

Other than natural ecosystems, there is a wide range of subject areas suitable for preliminary mapping training in the coastal zone. This includes (a) coastal land-use, (b) distribution of economic activities, and (c) human settlement patterns.

If diving capability is available, aquatic communities can be surveyed (as in the Case Study above). Similarly, availability of boats with on-board sampling gear would permit a wider range of offshore survey and mapping work (see Agard, 1984).

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Further Reading:

Putney, A. D. 1982. Final Report. Survey of Conservation Priorities in the Lesser Antilles. Caribbean Conservation Association, Technical Report 1; 30 pages.

Robinson, A.H. & Sale, R.D. 1969. Elements of Cartography, 3rd Edit. Wiley International; 415 pages.

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