BirdLife International Vietnam Programme
in collaboration with the
Institute of Ecology and Biological Resources

The Conservation of Key Wetland Sites in the Mekong Delta

Conservation Report
Number 12

BirdLife International Royal Netherlands Embassy IEBR

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Funded by

The Royal Netherlands Embassy
Hanoi

This report comprises the technical annex to the project entitled 'The Conservation of Key Wetland Sites in the Mekong Delta', activity number VN015401. This report is based on the results of conservation fieldwork conducted between January and August 1999 in the Mekong Delta, Vietnam.

Hanoi 1999

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Project Funding:	Royal Netherlands Embassy, Hanoi
Cover Illustration:	Bengal Florican *Houbaropsis bengalensis* by Norman Arlott
Citation:	Buckton, S. T., Nguyen Cu, Ha Quy Quynh and Nguyen Duc Tu (1999). *Conservation of Key Wetland Sites in the Mekong Delta*. BirdLife International Vietnam Programme Conservation Report No. 12. BirdLife International Vietnam Programme, Hanoi, Vietnam.
Design and Layout:	Lotus Communications
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Acknowledgements

A great many people contributed to this project through their knowledge and experience and we extend our sincere thanks to them all. The names of many of these people appear in Appendix 1, which comprises a directory of project correspondents. We would however like to extend our thanks to the district and provincial people's committees and citizens of An Giang, Bac Lieu, Ben Tre, Ca Mau, Can Tho, Dong Thap, Kien Giang, Long An, Soc Trang, Tien Giang, Tra Vinh and Vinh Long provinces and Ho Chi Minh City for their help and cooperation.

We would also like to express particular gratitude to Tran Triet of the International Crane Foundation and Nguyen Van Hung of Tram Chim National Park for assistance during sections of the fieldwork. Warm thanks are also due to Wandert Bentham of Arcadis-Euroconsult and Alun Larsen of CARE International for assistance in visiting their respective study sites.

We would also like to thank the following individuals and institutions for providing information, particularly unpublished material, or comments which assisted in the preparation of this report: Taej Mundkur (Wetlands International - Asia Pacific), Rebecca D'Cruz (Ramsar Convention Bureau), Roger Safford (Royal Holloway College), Tom Dahmer (Ecosystems Ltd.), Will Duckworth (World Wide Fund for Nature), Tony Whitten (World Bank), Doug Watkins (Wetlands International - Oceania), the Ministry of Agriculture and Rural Development, the Forest Inventory and Planning Institute, the Forest Protection Department, the Ministry of Science, Technology and Environment, and the Mangrove Ecology Research Division of the Centre for Natural Resources and Environmental Studies.

This project was exclusively funded by the Royal Netherlands Embassy in Hanoi.

Conventions used

Bird names (common and scientific), sequence and species limits follow Inskipp *et al*. (1996), with the exception of globally threatened or near-threatened species, for which Collar *et al*. (1994) is followed.

Mammal names (common and scientific) and species limits follow Corbet and Hill (1992).

Plant names (common and scientific) and species limits follow Pham Hoang Ho (1991-1993).

Abbreviations and acronyms used

ADB	=	Asian Development Bank
BAP	=	Biodiversity Action Plan
CBD	=	Convention on Biological Diversity
DBH	=	Diameter at Breast Height
EN	=	Endangered
FIPI	=	Forest Inventory and Planning Institute
FPD	=	Forest Protection Department
GEF	=	Global Environment Facility
GIS	=	Geographical Information System
IEBR	=	Institute of Ecology and Biological Resources
IUCN	=	World Conservation Union
MARD	=	Ministry of Agriculture and Rural Development
MoF	=	Ministry of Fisheries
MoSTE	=	Ministry of Science, Technology and Environment
MRCS	=	Mekong River Commission Secretariat
NGO	=	Non-Governmental Organisation
NT	=	Near-threatened
SIDA	=	Swedish International Development Agency
UNDP	=	United Nations Development Programme
VU	=	Vulnerable

Executive summary

The Mekong Delta is the major agricultural and fisheries production zone in Vietnam. Increasing human demand for natural resources, coupled with agricultural intensification, has significantly reduced the extent of natural and semi-natural habitats in the delta.

Rice grown in the delta now accounts for about half the total national production, and the country stands as one of the world's leading rice-exporting nations. Fisheries production is also an increasingly important foreign-exchange earner. These economic feats have only been achieved at great environmental cost. Few areas of natural or semi-natural habitat remain in the delta that are not subject to ever increasing levels of human exploitation, many of which are unsustainable.

The maintenance of the economic importance of the delta is dependent on maintaining ecosystem function, yet despite this, the current protected areas system may be inadequate in extent and insufficient in scope to adequately conserve representative biodiversity. Furthermore, the status of the delta's biodiversity is both poorly known and poorly documented.

The aim of the project was to:

(i) Assist the identification, evaluation and conservation of key wetland sites in the Mekong Delta.

The project objectives were to:

(i) Review existing and planned biodiversity conservation activities in the Mekong Delta;

(ii) Identify key wetland sites for biodiversity conservation, using indicator species and Ramsar criteria;

(iii) Conduct a preliminary assessment of current resource-use and of any future development plans at each site;

(iv) Produce a strategy prescription for the conservation of key wetland biodiversity sites in the Mekong Delta;

(v) Advocate the prescriptive measures, including the need for protected area establishment and Ramsar designation among relevant provincial and central government agencies;

(vi) Develop a project proposal or proposals, to address the conservation of a priority site or sites identified by the project; and

(vii) Provide training in survey and conservation assessment for Vietnamese scientific staff.

To fulfil these aims, a three-phase project was implemented by the BirdLife International Vietnam Programme and the Institute of Ecology and Biological Resources. In phase 1, wetland sites were identified by a combination of a literature review and interviews with provincial authorities, and evaluated through rapid assessments. Phase 2 comprised detailed habitat assessments and bird surveys of sites which met the evaluation criteria of the rapid assessment. In this phase, sites were further evaluated according to a set of 14 criteria, to rank sites according to the biodiversity importance and the feasibility of conservation action for each site. The conservation threats and requirements for each site were also assessed. Phase 3

involved the selection of a few sites of the highest biodiversity value which met the criteria for designation under international conventions, in particular the Convention on Wetlands (Ramsar Convention).

In all, 29 sites were identified and visited. These comprised 13 inland (freshwater) wetlands, nine coastal (saltwater) wetlands and seven non-wetland sites which provided important nesting or roosting sites for waterbirds. Of these, 10 were selected for detailed surveys on the basis of the rapid assessment criteria, of which eight were freshwater and two were coastal sites. Bird colonies were assessed separately.

In total, 194 species of bird were recorded, including 14 globally threatened or near-threatened species. Several species were represented at a single site by 1% or more of the global, regional or flyway population, including the globally endangered Chinese Egret *Egretta eulophotes*, and the near-threatened Asian Dowitcher *Limnodromus semipalmatus*, Sarus Crane *Grus antigone*, and Painted Stork *Mycteria leucocephala*. Amongst other groups of organisms, evidence was found for the continued existence of Sambar *Cervus unicolor* at one site.

Of the habitat types recorded, seasonally inundated grasslands and swamps, and mature semi-natural *Melaleuca* forest had the highest bird species richness. They also supported higher numbers of globally threatened and near-threatened bird species.

On the basis of the detailed phase 2 surveys, 10 priority wetland sites for conservation were evaluated and ranked as follows:

1 (highest) Seasonally inundated grasslands of the Ha Tien plain
2 Tram Chim National Park
3 U Minh Thuong Nature Reserve
4 Dat Mui Nature Reserve
5 Vo Doi Nature Reserve
6 Bai Boi
7 Tinh Doi
8 Tra Su
9 Lang Sen
10 (lowest) Lung Ngoc Hoang

The six highest-ranked sites were found to satisfy several of the criteria adopted by the Convention on Wetlands (Ramsar Convention) to identify wetlands of international importance. Two sites (Dat Mui and Bai Boi) also fulfil the criteria for designation under the East Asia-Australasia Shorebird Network. We recommend that all these sites are nominated by the relevant Vietnamese authority accordingly.

The highest priority for biodiversity conservation was found to be the seasonally inundated grasslands of the Ha Tien plain. This area contains unique aspects of biodiversity, including significant populations of several globally threatened and near-threatened birds. Of particular note were a group of over 130 Sarus Cranes, and a pair of the endangered White-shouldered Ibis *Pseudibis davisoni*. The area also shows high diversity in flora, including unique gradients from brackish to freshwater and from acid to alluvial vegetation communities.

There is an urgent need for establishment of two protected areas in the Ha Tien plain, as the grassland here is under serious threat from conversion to agricultural land. Currently, grassland is regarded as 'unused' land, and its conservation will be dependent on changing attitudes to this irreplaceable habitat.

In addition to the establishment of two new nature reserves in the Ha Tien plain, Kien Giang province,

we also propose that Bai Boi in Ca Mau province be decreed a nature reserve. Furthermore, three sites should have the area of the decreed nature reserve extended: U Minh Thuong (Kien Giang province), Vo Doi and Dat Mui (Ca Mau province). Four sites (Tra Su and Tinh Doi, An Giang province, Lang Sen, Long An province, and Lung Ngoc Hoang, Can Tho province) are not suitable for gazettement as nature reserves at national level due to their small size and/or severe management obstacles to overcome. However, establishing these as provincial level nature reserves would be a first step in improving the conservation importance and potential of these sites.

Of the bird colonies visited, Bac Lieu Nature Reserve, and Ca Mau, Tra Cu and Chua Hang bird sanctuaries held the largest numbers of birds including globally near-threatened species. However, the largest colony was that found within U Minh Thuong, which held over 5,000 birds, including up to 9% of the South-East Asian population of Glossy Ibis *Plegadis falcinellus*. However, this colony is not currently included in the decreed U Minh Thuong Nature Reserve, and we recommend that the protected area be extended to include this important colony.

To fully address the conservation issues operating in the Mekong Delta, an overall wetlands management strategy is needed. We propose a strategy addressing three main issues:

1. The establishment of a representative network of protected areas, both in terms of habitat representation and overall coverage.

We recommend the establishment of three new nature reserves, and extensions to three existing nature reserves, to increase the total area of the Mekong Delta protected as decreed nature reserve by 45,561 ha, from 22,509 to 68,070 ha. The total protected area would then constitute 1.7% of the total land area of the delta.

2. A shift in agricultural policy planning that recognises the social, economic and biodiversity values of wetlands, especially freshwater.

This includes the formulation of a national wetlands strategy, the identification of a national wetlands management authority, and fulfilment of the commitments made by Vietnam under the Convention on Biological Diversity and the Ramsar Convention. It also requires a reassessment of government resettlement policy, to ensure that the requirements of this policy to maintain ecological balance are taken into account.

3. Ensuring donor support is focused on freshwater ecosystems in the delta.

To date there has been an overemphasis on coastal zone projects in the Mekong Delta. In the future, donors should support conservation and sustainable management of freshwater wetlands.

Tóm Tắt

Đồng bằng sông Cửu Long là vùng sản xuất nông nghiệp và khai thác thủy sản quan trọng của Việt Nam. Tuy nhiên, do nhu cầu của con người về tài nguyên thiên nhiên ngày càng cao cùng với sự phát triển nông nghiệp đã làm suy giảm nghiêm trọng diện tích của các sinh cảnh tự nhiên và bán tự nhiên của vùng.

Lúa gạo ở đồng bằng sông Cửu Long hiện nay chiếm vào khoảng một nửa tổng sản lượng lúa của cả nước và đã góp phần đưa Việt Nam trở thành một trong những quốc gia xuất khẩu gạo lớn nhất thế giới. Khai thác thủy sản cũng là nguồn tăng thu nhập ngoại tệ quan trọng. Sự tăng trưởng kinh tế như vậy luôn đồng nghĩa với cái giá phải trả về mặt môi sinh. Chỉ rất ít vùng sinh cảnh tự nhiên và bán tự nhiên còn giữ lại được ở đồng bằng sông Cửu Long chưa là đối tượng khai thác của con người, hầu hết các vùng khác đều đang phải chịu sự khai thác không bền vững.

Việc gìn giữ vai trò kinh tế quan trọng của đồng bằng sông Cửu Long phụ thuộc vào việc đảm bảo được các chức năng của hệ sinh thái, mặc du vậy, hệ thống các khu bảo vệ đã được thiết lập hiện nay chưa thực sự tương xứng về quy mô cũng như không đủ phạm vi đại diện để bảo tồn tính đa dạng sinh học. Hơn thế nữa, hiện trạng đa dạng sinh học của đồng bằng sông Cửu Long rất ít được biết đến và cần phải được nghiên cứu nhiều hơn.

Từ đầu năm 1999, Chương trình BirdLife quốc tế tại Việt Nam và Viện Sinh thái và Tài nguyên Sinh vật đã tiến hành dự án Bảo tồn các vùng đất ngập nước Quan trọng ở Đồng bằng sông Cửu Long với mục đích chính là:

(i) Xác định, đánh giá và bảo tồn các vùng đất ngập nước quan trọng ở đồng bằng sông Cửu Long.

Các mục tiêu cụ thể được đề ra bao gồm:

(i) Rà soát lại các hoạt động bảo tồn đa dạng sinh học đã có và đang được hoạch định ở đồng bằng sông Cửu Long;

(ii) Xác định các vùng đất ngập nước quan trọng đối với công tác bảo tồn đa dạng sinh học bằng cách sử dụng các loài chỉ thị và các tiêu chí Ramsar;

(iii) Thực hiện bước đánh giá sơ bộ về hiện trạng sử dụng tài nguyên và các kế hoạch phát triển sắp tới tại mỗi vùng nghiên cứu;

(iv) Đưa ra một chiến lược để bảo tồn các điểm quan trọng ở đồng bằng sông Cửu Long;

(v) Ủng hộ các giải pháp nguyên tắc bao gồm yêu cầu thành lập các khu bảo vệ và đề xuất các khu Ramsar của các cơ quan liên quan ở cấp Tỉnh và Nhà nước;

(vi) Triển khai một hay nhiều đề nghị dự án, hay các khuyến nghị để tiến hành bảo tồn tại một hoặc nhiều điểm ưu tiên theo dự án xác định;

(vii) Cung cấp các kỹ năng về điều tra và đánh giá bảo tồn cho các cán bộ dự án.

Để thực hiện được các mục tiêu trên, dự án đã được triển khai theo 3 giai đoạn (pha). Giai đoạn 1, xác định các vùng đất ngập nước bằng cách tổng quan các tài liệu có sẵn, tham khảo ý kiến của cán bộ ở các tỉnh và điều tra theo phương pháp đánh giá nhanh. Giai đoạn 2, bao gồm đánh giá chi tiết các sinh cảnh cũng như tiến hành điều tra khu hệ chim ở

những điểm đáp ứng yêu cầu khi đánh giá nhanh. Trong giai đoạn này, các điểm được định giá thông qua 14 tiêu chí để xếp hạng theo tầm quan trọng về mặt đa dạng sinh học và mức độ khả thi cho các hoạt động ở mỗi điểm đó. Ngoài ra, những mối đe dọa và các yêu cầu đối với công tác bảo tồn tại mỗi khu vực cũng được đánh giá. Giai đoạn 3 tập trung nghiên cứu sâu một vài vùng có tính đa dạng sinh học cao, đặc biệt là những điểm đáp ứng các tiêu chí của các công ước quốc tế, nhất là Công ước về Đất ngập nước (Công ước Ramsar).

Tổng số có 29 điểm đã được xác định và tiến hành nghiên cứu. Trong đó, 13 điểm là các vùng đất ngập nước ngọt trong đất liền, 9 điểm ở các vùng ven biển (nước mặn) và 7 sân chim tuy không phải là vùng đất ngập nước nhưng cung cấp nơi làm tổ và trú chân quan trọng cho các loài chim nước. Mười điểm được lựa chọn trên kết quả đánh giá nhanh đã được điều tra chi tiết, 8 điểm trong số đó là các vùng đất ngập nước ngọt và hai điểm ở vùng ven biển. Các sân chim cũng được nghiên cứu riêng.

Đã phát hiện được tổng số 194 loài chim, trong đó có 14 loài đang bị đe dọa hoặc gần bị đe dọa tuyệt chủng trên toàn cầu. Một số loài đã tìm thấy ở vài nơi với số lượng cá thể chiếm hơn 1% số lượng quần thể toàn cầu, quần thể vùng hay quần thể trên một đường bay của loài, trong đó có cò trắng Trung Quốc *Egretta eulophotes* là loài đang bị đe dọa tuyệt chủng trên toàn cầu và các quần thể gần bị đe dọa tuyệt chủng là choắt chân màng lớn *Limnodromus semipalmatus*, sếu cổ trụi *Grus antigone*, và giang sen *Mycteria leucocephala*. Đối với các nhóm động vật khác, chứng cớ sự có mặt của nai *Cervus unicolor* ít nhất còn thấy tại một trong số các khu vực điều tra.

Trong các sinh cảnh được ghi nhận, các trảng cỏ hoặc đầm nước ngập theo mùa, và rừng tràm trưởng thành bán tự nhiên là những nơi có độ phong phú loài chim cao nhất. Đây đồng thời cũng là nơi có số lượng của các loài đang bị đe dọa tuyệt chủng trên toàn cầu nhiều hơn.

Dựa trên kết quả của hai giai đoạn điều tra chi tiết, 10 điểm đất ngập nước cần ưu tiên cho công tác bảo tồn đã được xác định và xếp hạng theo thứ tự ưu tiên như sau:

1 Các trảng cỏ ngập nước theo mùa ở vùng Đồng Hà Tiên
2 Vườn Quốc gia Tràm Chim
3 Khu BTTN U Minh Thượng
4 Khu BTTN Đất Mũi
5 Khu BTTN Vồ Dơi
6 Bãi Bồi
7 Tỉnh đội, An Giang
8 Trà Sư
9 Láng Sen
10 Khu BTTN Lung Ngọc Hoàng (đang đề nghị)

Sáu điểm được xếp hạng cao nhất (từ 1 đến 6) đều đáp ứng một vài tiêu chí của Công ước về Đất ngập nước (Ramsar) đưa ra để định loại các vùng đất ngập nước có tầm quan trọng quốc tế. Hai điểm (Đất Mũi và Bãi Bồi) đồng thời cũng đáp ứng các tiêu chí để đề cử vào Mạng lưới Các vùng Chim di cư Ven biển Đông Á - Úc châu. Chúng tôi cũng lưu ý các cơ quan có thẩm quyền của Việt Nam cần đề xuất những vùng này với các tổ chức quốc tế có liên quan.

Vùng cần ưu tiên cao nhất cho bảo tồn tính đa dạng sinh học tại đông bằng sông Cửu Long được xác định là Các trảng cỏ ngập nước theo mùa ở vùng Đồng Hà Tiên. Vùng này có ý nghĩa đặc biệt về mặt đa dạng sinh học, vì đây là nơi cư trú của một số loài chim đang bị đe dọa tuyệt chủng trên toàn cầu. Đặc biệt chúng tôi đã ghi nhận sự có mặt của một đàn sếu cổ trụi với khoảng hơn 130 cá thể và một đôi cò quăm cánh xanh. Vùng này cũng là nơi có độ đa dạng thực vật cao, bao gồm các cấp độ của các quần xã thực vật ở nước lợ đến

nước ngọt và từ đất axit đến đất phù sa bồi tụ.

Rất cần thiết hình thành ngay 2 khu bảo vệ ở vùng Đồng Hà Tiên vì vậy vì các trảng cỏ ở đây đang bị đe dọa nghiêm trọng do việc cải tạo đất nông nghiệp. Trong thời gian gần đây, các vùng trảng cỏ vẫn được coi như là đất "hoang hoá", việc bảo tồn chúng sẽ góp phần làm thay đổi quan điểm về kiểu sinh cảnh không thể thay thế này.

Ngoài việc hình thành ngay 2 khu bảo vệ ở vùng Đồng Hà Tiên, tỉnh Kiên Giang, chúng tôi cũng đề nghị vùng Bãi Bồi ở tỉnh Cà Mau cần được công nhận trong hệ thống rừng đặc dụng và một số khu khác đã được công nhận cần được quyết định mở rộng hơn là U Minh Thượng (tỉnh Kiên Giang), Vồ Dơi và và Đất Mũi (tỉnh Cà Mau). Bốn điểm (Trà Sư và Lâm trường Tỉnh Đội, tỉnh An Giang; Láng Sen, tỉnh Long An và Lung Ngọc Hoàng, tỉnh Cần Thơ) chưa phù hợp với việc công bố vào hệ thống khu bảo vệ do diện tích quá bé và/hoặc do một số khó khăn về công tác quản lý cần phải vượt qua. Tuy nhiên, thiết lập các khu bảo tồn thiên nhiên cấp tỉnh ở những vùng này sẽ là bước khởi đầu để cải thiện tầm quan trọng và tiềm năng bảo tồn cho vùng.

Đối với các sân chim, Sân chim Bạc Liêu, Sân chim Cà Mau, Sân chim Trà Cú và Chùa Hang là nơi có số lượng chim lớn nhất bao gồm cả khoảng 9% quần thể Đông Nam Á của loài quắm đen nhỏ *Plegadis falcinellus*. Tuy nhiên, sân chim này hiện chưa nằm trong trong Khu BTTN U Minh Thượng và chúng tôi đề nghị cần mở rộng diện tích khu BTTN bao trùm cả vùng chim quan trọng này.

Để đáp ứng các vấn đề bảo tồn ở đồng bằng sông Cửu Long, nhất thiết phải có ngay một chiến lược cho công tác bảo tồn tổng thể các vùng đất ngập nước. Chúng tôi đề nghị một chiến luợc để giải quyết 3 vấn đề chính sau:

1. Thiết lập một hệ thống các khu bảo vệ đất ngập nước đáp ứng yêu cầu đại diện về mặt sinh cảnh và tiêu biểu về phạm vi tổng thể.

Chúng tôi đề nghị thiết lập thêm 3 khu BTTN mới và mở rộng diện tích của ba khu hiện đã có quyết định công nhận là khu BTTN, tăng tổng số diện tích trong hệ thống bảo vệ ở đồng bằng sông Cửu Long thêm 45,561 ha, từ 22,509 ha lên 68,070 ha, để diện tích được bảo vệ ở đồng bằng sông Cửu Long tăng lên 1,7% diện tích tự nhiên của vùng.

2. Cần có sự sửa đổi một số chính sách hoạch định nông nghiệp theo hướng có cân nhắc đến các giá trị về mặt đa dạng sinh học, kinh tế và xã hội của các vùng đất ngập nước.

Hệ thống hóa một chiến lược quốc gia về đất ngập nước, xác định một cơ quan nhà nước có chức năng quản lý đất ngập nước và thực hiện những cam kết của Việt Nam trong các Công ước về Đa dạng Sinh học và Công ước Ramsar. Điều này đòi hỏi phải có quá trình đánh giá lại các chính sách về bố trí dân cư của Chính phủ, đảm bảo những chính sách này vẫn duy trì được sự cân bằng sinh thái.

3. Thúc đẩy sự chuyển hướng để các nguồn tài trợ tập trung hơn nữa vào các vùng đất ngập nước ngọt.

Hiện tại, các dự án ở đồng bằng sông Cửu Long đang quá tập trung vào các vùng ven biển. Trong tương lai, các nhà tài trợ nên chú ý nhiều hơn nữa đến việc bảo tồn và quản lý bền vững các vùng đất ngập nước ngọt.

1. Introduction

The Mekong Delta is the major agricultural and fisheries production zone in Vietnam. Increasing human demand for natural resources, particularly land for agriculture and aquaculture, coupled with agricultural intensification, has significantly reduced the extent of natural and semi-natural habitats in the delta. Policy reforms since the *doi moi* (national revitalisation) era was launched in the mid-1980s have led to a further and continuing expansion of land under cultivation and further intensification of food production. Rice grown in the delta accounts for about half the total national production, and the country now stands as one of the world's leading rice-exporting nations. Fisheries production is also increasingly important as a source of foreign exchange.

This economic feat has only been achieved at great environmental cost. Few areas of natural or semi-natural habitat remain in the delta that are not subject to increasing levels of human exploitation, many of which are likely to be unsustainable. For example, areas of seasonally inundated grassland, which support the last remaining populations of wild rice, are rapidly being converted to rice paddy. The acid-sulphate soils upon which these grasslands are situated are marginal for agriculture and the viability of agriculture in these areas is often questionable. The poorly regulated development of aquaculture ponds in the southern Mekong Delta has led to the widespread destruction of mangrove forests, which play a vital role in maintaining the ecological stability of the coastal zone. Furthermore, destruction of mangrove forest has serious consequences as it provides vital habitat for fish fry and the larval stages of other commercially important marine fauna.

The economic value of the delta depends on maintaining ecosystem functions. Yet the current protected areas system may be inadequate in extent and scope to adequately conserve representative biodiversity. The status of the delta's biodiversity is both poorly known and documented. Thus, land-use planners in both provincial and central governments do not have sufficient information on which to base important and often irreversible decisions. These will have a profound impact on the people, landscape and biodiversity of this area for the foreseeable future. As the rate of land-use change continues to accelerate it is vital to pinpoint areas of high biodiversity so that their conservation can be addressed. Carefully planned protected areas can maintain ecological stability, conserve biodiversity and support agricultural and aquacultural production, thereby helping to guarantee the economic and social stability of the delta.

1.1 Project justification

Vietnam's signing of the Convention on Biological Diversity (CBD) in 1993, ratified in 1994, committed Vietnam to increase its protected area coverage to two million hectares by the year 2000. Within the scope of the CBD, Vietnam formulated a national Biodiversity Action Plan (BAP), ratified under Resolution No. 845/TTg of the Prime Minister, dated 22 December 1995. Under this document, Vietnam has recognised the importance of wetlands in supporting biodiversity, and has committed itself to establishing a number of protected areas encompassing important wetlands in areas of high biodiversity value. To this end, the Ministry of Science, Technology and the Environment (MoSTE) is compiling a national inventory of wetlands for Vietnam. The project described in this document has provided much of the data on which wetlands in the Mekong Delta have been evaluated under the MoSTE inventory.

The BirdLife International Vietnam Programme and the Forest Inventory and Planning Institute (FIPI) are currently engaged in a project entitled 'Expanding the Protected Areas Network in Vietnam for the 21st Century'. This initiative has analysed the extent to which the current protected area system incorporates a representative component of Vietnam's species and ecoregions in terrestrial forest

ecosystems. This initiative has also identified sites that should be included to ensure Vietnam conserves a representative component of its forest biodiversity (Wege *et al.* 1999). For wetland sites, FIPI and the BirdLife International Vietnam Programme undertook an assessment of priorities for wetland conservation in the coastal zone of the Red River Delta (Pederson and Nguyen Huy Thang 1996). The Mekong Delta is the major wetland zone in Vietnam, and the project described in this document fills an important gap in the information available on wetland biodiversity values in Vietnam. Recommendations for revisions to the protected area network resulting from this project are intended to complement those derived from Wege *et al.* (1999) and Pederson and Nguyen Huy Thang (1996).

1.2 Aim and objectives

The aim of the project was to:

(i) Assist the identification, evaluation and conservation of key wetland sites in the Mekong Delta.

The objectives of the project were to :

(i) Review existing and planned biodiversity conservation activities in the Mekong Delta;

(ii) Identify key wetland sites for biodiversity conservation, using indicator species and Ramsar criteria;

(iii) Conduct a preliminary assessment of current resource-use and of any future development plans at each site;

(iv) Produce a strategy prescription for the conservation of key wetland biodiversity sites in the Mekong Delta;

(v) Advocate the prescriptive measures, including need for protected area establishment and Ramsar designation among relevant provincial and central government agencies;

(vi) Develop a project proposal or proposals, to address the conservation of a priority site or sites identified by the project; and

(vii) Provide training in survey and conservation assessment for Vietnamese scientific staff.

2. Conservation in Vietnam

The government of Vietnam recognised the need for conserving and rehabilitating the natural environment at the end of the 1970s. Its first priority was to provide areas for settling war veterans. The second priority was chemical detoxification and remediation for human resettlement of areas affected by chemical defoliants. The third priority was given to reforestation, establishing protected areas and conversion of forests into cultivated land (Ministry of Forestry 1991a). Only in the 1990s has the conservation emphasis moved towards protecting endangered habitats and species.

2.1 The protected areas system in Vietnam

Protected areas in Vietnam comprise a component of the national system of forest categorisation. Vietnam's forests are divided into three categories (Ministry of Forestry 1991a,b):

Production Forests. These are forested areas which can be allocated to any organisation or individual (with management requirements and harvesting regulations) for domestic commercial timber needs as stipulated in Vietnam's Forestry Law, Articles 28-34;

Protection Forests. These forested areas can be allocated to forestry agencies, people's committees or to the people directly, for the main purposes of watershed protection, soil-erosion control, and foreshore protection with special provisions as per Articles 35-37;

Special-use Forests (Protected Areas). These are forested lands allocated for environmental conservation, tourism, educational purposes, national defence and other special uses. These lands can be allocated to organisations and agencies in the state forestry sector which are expected to generate revenues outside of the strict protection areas and follow management procedures as per Articles 39-41. In general, protected areas are managed by management boards, but arrangements are complex, and vary from one area to another. Some management boards are directly responsible to MARD (such as those for most national parks), whilst others are responsible to provincial government. Special-use Forests are further subdivided into:

- *Cultural and Historical Sites* to preserve and maintain areas of national and cultural interest and importance;
- *Nature Reserves* intended to preserve all representative vegetation types and to conserve biodiversity; and
- *National Parks* to protect and conserve all major wildlife and habitat types found within Vietnam.

Vietnam currently has proposals for 105 protected areas, comprising 976,000 ha or 3% of the total land area. If these proposals are adopted, there will be 10 national parks, 61 nature reserves, and 34 cultural or historical sites (Dang Huy Huynh 1998). Vietnam is actively gazetting new sites as part of its obligations under the CBD. The policy document entitled Renovation of Strategies for Forestry Development until the Year 2000 contains a commitment to expand Vietnam's system of Special-use Forests to 2 million hectares by the year 2000, thereby doubling the network of protected areas.

2.2 Wetland conservation in Vietnam

Article 11 of the Land Law (1993) classifies land into 'agricultural, forestry, rural residential, urban,

special use, and land not-in-use'. Wetlands, as defined under the Convention on Wetlands (Ramsar Convention; Box 1), can fall into most of these categories, and therefore do not fit well into the current system of protected area categorisation, which allows only for sites to be designated as Special-use Forest. Many Vietnamese wetlands of importance for biodiversity include areas of seasonally inundated or swamp-forest, and protected areas thus far established in the Mekong Delta all include *Melaleuca* or mangrove forest. However, other wetlands, including seasonally inundated grasslands and open swamps have, by definition, been omitted from the protected area system, irrespective of their value for biodiversity conservation.

BOX 1
What are wetlands?

Wetlands are defined under the Convention on Wetlands (Ramsar Convention) as:
'areas of marsh, fen, peatland or water, whether natural of artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres'

An additional provision is that they:
'may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetland'.

Thus wetlands include areas that are seasonally flooded, including forest and grassland, that may be dry for part of the year.

Government policy with relevance to wetlands. The policy of conversion of 'unused land' (which under the Land Law includes many wetlands) to agricultural land is described in a Prime Ministerial Resolution on 'exploitation and utilisation of uncultivated lands, estuary and coastal mudflats and water bodies in the plains and basins' (Prime Ministerial Resolution number 773/TTg 1994). This states in Article 1 that:

- ' From now until 2000 and beyond, the government should use all available capital (both home and foreign) to implement development of unused land resources. All efforts should be concentrated on the Plain of Reeds, Long Xuyen Quadrangle and Ca Mau peninsular, and other subregions of the Mekong Delta, Red River Delta and coastal regions in Central Vietnam. In general it aims to conserve Special-use Forests, coastal Protection Forest and to increase the standard of living of local people.'

Taken alone, Article 1 would imply that all efforts should be directed towards agricultural conversion, clearly contradicting policy objectives outlined in the CBD and Ramsar Convention. However, Articles 3, 4 and 5 require that:

- All projects on agriculture, forestry and aquaculture production should follow the social and economic plan of each region, and ensure sustainable exploitation and environmental protection.

- Each project should pay attention to increasing the area of coastal Protection Forest, and mangrove plantation, with the aims of maintaining the ecological balance and providing construction materials and fuelwood for local people. Forest cover of each project should cover 20-30% of natural lands.

- All projects on aquaculture should be combined with other land uses for good environmental protection.

Resolution 773 is the first legislative document regulating the exploitation and utilisation of wetlands in Vietnam, and has also been the driving force behind much of the agricultural development in the Mekong Delta.

Another Prime Ministerial resolution with relevance to Mekong Delta wetlands describes the 'objectives, duties, policies and organisation for implementation of the project on new planting of more than 5 million ha of forests' (Resolution number 661/QD-TTg dated 27 July 1998) calls for the planting of 5 million ha of land with trees by the year 2010. The aim of this policy is to increase national forest coverage to 43% using 'unused land'. This policy has encouraged reforestation large areas of the delta with *Melaleuca*. The resolution includes within it a provision to conserve genetic resources and biodiversity. While *Melaleuca* rehabilitation can be beneficial to biodiversity conservation in degraded areas, there is likely to be a negative effect when this practice is carried out over seasonally inundated grassland and swamp, which have high biodiversity values themselves.

International conventions. Vietnam is a signatory to two international conventions with relevance to wetland conservation.

The Convention on Biological Diversity (CBD). Signatories are obliged, amongst other things, to:

- Develop national strategies for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies;
- Integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies;
- Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;
- Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas;
- Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
- Promote environmentally sound and sustainable development in areas adjacent to protected areas;
- Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species;
- Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species; and
- Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components.

Vietnam is also a signatory to the **Convention on Wetlands** (**Ramsar Convention**), under which Vietnam is committed to:

- Designate and promote the conservation of at least one Ramsar site (although members are encouraged to designate all of their sites that are 'internationally important');
- Formulate and implement planning for the wise use of all wetlands in their territory;
- Establish conservation areas and promote training in wetland research and management;
- Cooperate internationally on transboundary wetlands and water resources, shared wetland species and development aid for wetland projects; and
- Contribute to the Convention budget.

To date, one Ramsar site, at Xuan Thuy in the Red River Delta has been designated in Vietnam. No further sites have yet been designated, though two (Tram Chim in Dong Thap province, and the Tam Giang lagoon system in Thua Thien Hue province) are currently under discussion. Designation of Ramsar sites is a simple process and sites meeting the criteria for Ramsar designation identified in this project (see below) should be notified as soon as possible. This will highlight their importance to the international community and thus assist in securing funding for conservation and sustainable development.

Government agencies responsible for wetland conservation and management. As protected areas are currently classified as Special-use Forest, responsibility for management of protected areas lies with the Forest Protection Department (FPD) of the Ministry of Agriculture and Rural Development (MARD). The Ministry of Fisheries (MoF) has some responsibility for coastal and marine wetlands, while the responsibility for the implementation of the BAP for Vietnam lies principally with MoSTE. There is therefore no single governmental body assigned to take responsibility for wetland management and conservation.

3. Description of the Mekong Delta

3.1 Physical setting

The Mekong River is the largest river in South-East Asia. It rises in the mountains of China, and flows through or along the borders of Myanmar, Laos, Thailand and Cambodia before bifurcating into the Mekong and Bassac Rivers immediately downstream of Phnom Penh in Cambodia. The river branches further to form an extensive delta covering some 4.95 million ha, 3.9 million of which lie in Vietnam. The Mekong and Bassac both then drain into the South China Sea and the Gulf of Thailand. Most of the natural wetland habitat in the delta has been reclaimed for wet-rice cultivation and the delta supports a high human population (16.9 million in 1996; Duong Van Ni *et al*. in press).

Climate. The Mekong Delta has a tropical monsoon climate, with distinct wet and dry seasons. Mean daily temperatures show little variation throughout the year, typically ranging from 26°C in January to 29°C in April. December to March constitute the dry season, while in April humidity and temperatures increase until the rains begin, usually in May. Most rain falls in September and October. There are local variations in climate; for example the south-west of the delta receives twice as much rain each year (2,500 mm) as parts of the north (1,250 mm).

Hydrology. The large seasonal variation in climate results in an equally large variation in flow of the Mekong River. At the peak of flows, large parts of the delta flood, particularly the northern areas. Depth and duration of flooding vary according to location and intensity of monsoon rains, but can be as deep as 3 m and last for 4-5 months in low-lying areas. Flows are lowest in April, and at this time seawater is able to move upstream to inundate approximately one third of the entire delta. Even in the wet season, saltwater inundation occurs during high tides in parts of the south-east (Le Cong Kiet 1994).

The flooding regime is of great importance to productivity in the delta. Annual flooding brings millions of tonnes of suspended and dissolved solids into the aquatic system, and much of this is deposited on agricultural land, providing sufficient nutrients to support two or three rice crops each year in many areas.

Soils. The soils in the Mekong Delta are derived from sediment transported by the Mekong River. Three main soil classes are recognised (Le Cong Kiet 1994): old alluvial sediments in parts of the northern delta; non-acidic alluvial soils in much of the central area, where land is most suited to rice growing; and acid-sulphate soils, which are found mainly in the north-west and north-east. The latter type is the least suitable for agriculture, especially rice cultivation (see Box 2).

BOX 2
The acid-sulphate soil problem

Soils rich in pyrite (Fe_2S), known as acid-sulphate soils, occupy more than 40% of the Mekong Delta. Pyrite accumulates in waterlogged soils that are both rich in organic matter and flushed by water containing dissolved sulphate (usually seawater), a scenario common in delta regions. If such soils remain waterlogged they are termed 'potential' acid-sulphate soils, as they will only produce acid conditions when oxidised. However, when the soils become dry, through drainage or periods of low rainfall for example, pyrite is exposed to the air and oxidises to form sulphuric acid (H_2SO_4). Any water draining from these 'active' acid-sulphate soils will be highly acidic: in the Mekong Delta surface water with a pH of less than 3 is not uncommon. However, the low pH in itself is not a major problem. The main impact comes from highly toxic levels of aluminium and ferrous iron, which are leached from soils by sulphuric acid. In these conditions, phosphorus is precipitated as insoluble ferric and aluminium phosphates, and becomes unavailable for plant uptake. This has serious consequences for plant growth rates. Aluminium is also known to be toxic to fish and many other components of the aquatic ecosystem.

Many forms of cultivation involve processes that lead to exposure of soil to air. Although rice production requires flooding for part of the year, the associated channelisation has a two-fold effect on the acid-status of the soil. Firstly, dredging of material onto canal banks expose this soil to air, thus oxidising it. Secondly, channelisation accelerates drainage so that soils are more likely to lose their moisture in the dry season and become oxidised. The resulting water, essential for rice production, may therefore become highly acidic, and heavily laden with toxic aluminium and iron ions, with negative impacts on rice production. In areas where rainfall is lower, these soils dry out every dry season and will continue to produce acid conditions for many years. In areas where flooding is more intense and occurs over a longer period of time, much of the toxicity associated with acidification is washed out.

In the Mekong Delta, research suggests that *Melaleuca* cultivation provides a more economically viable alternative to rice growing in some areas of acid-sulphate soils. There is some evidence that *Melaleuca* even acts as an ameliorative mechanism, reducing the levels of toxic aluminium and iron ions in the water in which it is grown.

Landform zones. Three main landform types have been described in the Mekong Delta (Nguyen Huu Chiem 1993): the floodplain; the coastal complex; and the broad depression. These categorisations are based on interlinked climatic, hydrological and soil processes.

The floodplain is the largest landform type, covering much of the northern and central part of the delta. It is further subdivided into the high floodplain (so-called because it has the greatest depth of floodwater inundation) and the tide-affected floodplain, which is strongly affected by tidal rivers. The high floodplain is located in the north-west of the delta and consists of natural levees, sandbars, and backswamps. The 'closed' section of the high floodplain is known as the Plain of Reeds, where drainage of floodwaters is slow and difficult, and flooding to a depth of up to 3 m occurs for much of the year. The 'open floodplain' section is so called because it slopes gently towards the Gulf of Thailand so that floodwater can easily drain away, and floods to only 1.5-2 m. This region is known as the Long Xuyen Quadrangle, and includes the Ha Tien plain. In both areas, soils with high acid-sulphate content are dominant.

The tide-affected floodplain occupies the centre of the delta. Inundation depths are considerably lower than the high floodplain, typically reaching only 0.5-1 m in depth in September and October. Although acid-sulphate soils are found here, their influence is less because the rivers wash away much of the toxicity, and as a result this part of the delta is most suited to agriculture.

The coastal complex constitutes the coastal regions of the southern and easternmost delta. Landforms here are influenced by marine and river environments, and are made up of coastal flats, sand-ridges, inter-ridge flats and mangrove swamps. Coastal flats lie between 1 and 1.5 m above sea level and are not directly inundated by saltwater, though seawater can enter the soils by capillary action. Sand-ridges have formed parallel to the coastline in the eastern delta provinces, and rise to 2-5 m above sea level. Between them lie inter-ridge flats, which are covered by saltwater during the dry season and freshwater during the wet. Acid-sulphate soils are common in all three areas but have little effect as the toxic products of acidification are frequently washed out and fresh sediments deposited on top. Thus the area is suitable for agricultural production. Mangrove swamps are found primarily in the Ca Mau peninsular and around river mouths in all the east-facing coastal provinces. In some areas, particularly the Ca Mau peninsular, mangrove spreads seawards as accretion creates shallow areas suitable for colonisation.

The broad depression occupies a large area in the south of the delta, mainly in Kien Giang and Ca Mau provinces. It is largely isolated from the river system, and as a result freshwater is scarce in the dry season. At this time the acid-sulphate soils that predominate are prone to dry out and oxidise, causing acid conditions when re-flooded. Much of the area is frequently inundated with saltwater during the dry season. The remaining areas of the broad depression are the peatswamps of U Minh. They are low-lying areas with large peat deposits, which can be inundated to 1-1.5 m during the wet season. The peat soils hold a large volume of water throughout the dry season, providing an important source of irrigation water for surrounding agricultural areas.

3.2 Vegetation

Although there is evidence from tree stump remains that the delta was once heavily forested (Le Cong Kiet 1993), the character of the delta has changed to such an extent during its long occupation by humans that little is known of the original vegetation. However, the vegetation communities existing today have been extensively studied (Le Cong Kiet 1994; Tran Triet 1999).

Natural and semi-natural vegetation communities reflect the climatic, soil and hydrological conditions found in the delta, and can be divided into freshwater and saline communities. Freshwater communities can be further divided into swamp-forest vegetation, herbaceous vegetation, riverbank vegetation, and aquatic vegetation in waterways and waterbodies (Le Cong Kiet 1994). Saline communities consist largely of mangrove forest.

Freshwater vegetation. Some confusion has existed regarding the dominant tree species in Mekong Delta swamp-forest, but it has been confirmed that the only species found so far in the Mekong Delta is *Melaleuca cajuputi* (Craven and Barlow 1997). This species forms semi-natural forest in some areas, though the majority is plantation. Throughout this report, reference to *Melaleuca* indicates *Melaleuca cajuputi*.

Species forming the ground layer in swamp-forests vary according to local conditions, but include *Phragmites vallatoria* and *Eleocharis* spp. grasslands.

Herbaceous vegetation includes extensive areas of seasonally inundated grassland which have been subdivided into four main groups (Tran Triet 1999):

- Grassland on areas of deep and prolonged freshwater inundation that are dominated by *Eleocharis dulcis*, *Oryza rufipogon* and *Phragmites vallatoria*, occurring on potential or light active acid-sulphate soils.

- Grassland on active acid sulphate soils that are dominated by *E. dulcis*, *E. ochrostachys*, *Ischaemum rugosum* and *Lepironia articulata*, and inundated with freshwater to a moderate depth and for a moderate duration.

- Grassland on sandy and old alluvium soils that are dominated by *Eragrostis atrovirens*, *Setaria viridis*, *Mnesithea laevis* and *Panicum repens*, and inundated only to a shallow depth and for a short time.

- Grasslands affected by brackish water that are dominated by *Paspalum vaginatum*, *Scirpus littoralis*, *Zoysia matrella*, *Eleocharis dulcis* and *E. spiralis*. They are affected by brackish water and can be inundated on a daily basis due to tides.

BOX 3
Grasslands: not wastelands

In Vietnamese legislation, under Article 11 of the Land Law (1993), land is classified into '**agricultural, forestry, rural residential, urban, special use, and land not-in-use**'.

Unfortunately, grasslands are frequently deemed to be 'not-in-use', and therefore seen as 'wasteland'. This fails to recognise the unique biodiversity which grasslands support. In the Mekong Delta seasonally inundated grasslands provide habitat for globally threatened birds, including Bengal Florican *Houbaropsis bengalensis* and White-shouldered Ibis *Pseudibis davisoni*. The habitat also supports at least 60% of the population of the eastern subspecies of Sarus Crane *Grus antigone sharpii* in the dry season. These grasslands also contain unique vegetation communities, some of which are not likely to be found elsewhere in Indochina. The saline influence and predominance of acid-sulphate soils in the delta have a strong influence on the species composition of plant communities found here.

Most seasonally inundated grassland in the Mekong Delta is now confined to the Ha Tien plain and the Plain of Reeds. In the Ha Tien plain, substantial areas still exist, but none has any form of protection and is in imminent danger of being lost to rice cultivation. Almost all the grassland of the Plain of Reeds has been converted to rice agriculture, with only a small fragment under conservation protection in Tram Chim National Park.

Saline vegetation. The main factors determining the composition of flora in mangrove forests are salinity and soil properties (Euroconsult *et al.* 1996). In the Mekong Delta, *Avicennia alba* dominates newly accreted land that is inundated often even at low tide, with some *Bruguiera* also occurring. In higher areas, which are only inundated at high tide, *Rhizophora* species, primarily *R. apiculata*, dominate. Where land is only inundated by particularly high spring tides, communities including *Lumnitzera racemosa*, *Ceriops tagal*, *Excoecaria agallocha* or the palm *Phoenix paludosa* can be found. Stands of the rhizomatous palm *Nypa fruticans* are characteristic of brackish areas.

BOX 4
Mangrove replanting

Natural mangrove forests of the Mekong Delta have been almost entirely lost, due to a combination of wartime conflict, especially defoliant spraying, and more recent clearance for aquaculture and through exploitation of forest products.

The coastal dynamics of the Mekong Delta are varied, with high erosion rates occurring along parts of the eastern coastline and rapid accretion rates on the Ca Mau peninsular and at the mouths of the major discharge points of the Mekong River distributaries. Highest rates of erosion have occurred where mangrove has been destroyed, often through reduced protection from tropical storms and typhoons, leading to the loss of valuable agricultural land and an increase in saline water intrusion into rice growing areas further inland. This has resulted in the recognition of the important role mangrove plays in maintaining the agricultural system in the delta, at least in part. To combat this, widespread mangrove planting has taken place, often with the assistance of substantial funds from international donors.

Unfortunately however, mangrove planting regimes often fail to maximise the potential for restoration of biodiversity conservation, and in some areas can actually be detrimental. Planting regimes fail in three main ways:

- Planting is often too dense, frequently more than 3 stems m^{-2}. This results in rapid growth but also in mangrove trees with slender stems which are easily uprooted in high winds that occur in the frequent tropical storms and typhoons experienced in the delta;
- Planting often only involves a single species, and the dense monocultures resulting do not allow other species to colonise. This results in a low diversity of other plants and animals;
- While planting along erosive coastlines is probably necessary to enable mangrove to establish a foothold, it often also takes place in areas where erosion is not severe. These areas would become naturally re-colonised by mangrove over time, resulting in a more natural structure and higher diversity of mangrove species and associated plants and animals.

3.3 Fauna

The Mekong Delta supports a diverse fauna, in a range of habitats including coastal mudflats and mangroves, seasonally flooded grassland and *Melaleuca* forest, open swamps and agricultural land. Much of the fauna of the Mekong Delta remains little studied and delta-wide descriptions of fauna are largely lacking.

Mammals. The mammal fauna of the Mekong Delta is poorly documented, and it is likely that it has been severely depleted as a result of conversion of land to agriculture and expansion of the human population. As the delta was settled by the Vietnamese over 300 years ago, and by the Khmer people since c. 200 AD, we can only postulate what the mammal fauna would have consisted of in the past. However, given the tree-stump evidence for the historical presence of dense forest, it is likely that a

mammal megafauna, including Water Buffalo *Bubalus arnee*, Asian One-horned Rhinoceros *Rhinoceros sondaicus* and Tiger *Panthera tigris* once existed.

Le Dien Duc (1989) listed 23 species of mammal as occurring in the delta, including five species of dolphin, Crab-eating Macaque *Macaca fascicularis*, Smooth-coated Otter *Lutragale perspicillata* and Fishing Cat *Prionailurus viverrina*. Safford *et al.* (in press) provide evidence for the continuing occurrence of the latter three species, as well as Sunda Pangolin *Manis javanica*, Cambodian Striped Squirrel *Tamiops rodolphii*, an unidentified *Callosciurus* squirrel, an unidentified otter *Lutra* sp., Common Palm Civet *Paradoxurus hermaphroditus*, Small Asian Mongoose *Herpestes javanicus*, Leopard Cat *Prionailurus bengalensis*, Wild Boar *Sus scrofa* and Sambar *Cervus unicolor* in the U Minh wetlands, although for several species this was based on the existence of zoo specimens. It is likely that other otter species once occurred in the delta, and some may remain, including Hairy-nosed Otter *Lutra sumatrana* and Oriental Small-clawed Otter *Aonyx cinerea* (J. W. Duckworth, *in litt.*)

Birds. Le Dien Duc (1989) listed 92 species of waterfowl in the delta, and noted important colonies of cormorants, herons, egrets, storks and ibises. More recently, the avifauna of a small number of sites has been described in brief. Safford *et al.* (in press) described 122 species for the U Minh wetlands of Kien Giang and Ca Mau provinces, including nine globally threatened or near-threatened species. Tran Triet *et al.* (in press) found evidence for 74 species in the grasslands of Ha Tien, including the globally endangered Bengal Florican *Houbaropsis bengalensis*. The avifauna of Tram Chim National Park is probably the best known in the delta, where over 170 species have been recorded (International Crane Foundation, unpublished data). A number of globally threatened large waterbirds that were believed to occur in the delta in the past, most notably Giant Ibis *Pseudibis gigantea*, Milky Stork *Mycteria cinerea*, Black-necked Stork *Ephippiorhynchus asiaticus*, Greater Adjutant *Leptoptilos dubius* and White-winged Wood Duck *Cairina scutulata*, are now almost certainly extinct as breeding birds in the delta.

Fish. About 260 species of fish are known from the Mekong Delta (Le Dien Duc 1989). Many species are migratory, showing seasonal upstream movements, and some reach as far as the freshwater zone to spawn. The brackish and coastal zone fauna is dominated by species in the families Clupeidae, Scombridae, Sciaenidae, Tachysauridae and Cynoglossidae. In freshwater, the fish fauna is dominated by Cyprinidae, Siluridae, Clariidae, Schilbeidae, Bagridae, Sisoridae, Akysidae, Chanidae and Ophicephalidae.

Reptiles and amphibians. No detailed surveys of reptiles and amphibians have been carried out in the Mekong Delta. However, historical information is available on some species known to exist either now or in the past. Most notable amongst reptiles are Estuarine Crocodile *Crocodylus porosus*, Batagur Terrapin *Batagur baska*, four species of water snake *Enhydris* spp., Water Monitor *Varanus salvator* and Reticulated Python *Python reticulatus* (Le Dien Duc 1989). However there is a lack of data regarding the current status of any of these species in the Mekong Delta.

3.4 Land-use and economy

Agriculture. Agricultural land use in the Mekong Delta consists mostly of rice cultivation, and the delta is the country's major rice-producing area, responsible for some 50% of national production in 1993 (General Statistical Office 1994). A number of different rice growing regimes operate in the delta, including rain-fed wet rice and irrigated wet rice, with single or multiple cropping. Cropping regimes depend to a large extent on soil fertility and acid status. In areas of active acid sulphate soil more than a single crop is rarely achievable and in strongly acidic areas productivity is often less than one tonne of rice ha^{-1} yr^{-1}. In areas without an acid-sulphate soil problem three crops of rice a year are possible, normally yielding some 12 tonnes ha^{-1} in total. Other crops are grown in the Mekong Delta to a lesser extent, including sugar cane, pineapples, sweet potato, cassava, yam, watermelon, soybean and pumpkin.

Forestry. *Melaleuca* and mangrove forests provide a number of benefits to local people. The timber is valued for construction of housing, and is also used as a fuelwood. The production of honey is practised in *Melaleuca* forest, and honey harvested from wild bees is particularly highly valued. *Melaleuca* is also now widely recognised as being suitable for planting on acid-sulphate soils, as its cultivation does not involve the creation of raised beds. *Melaleuca* cropping cycles often involve a first crop of poles taken after 8-10 years growth, after which stumps are left in the ground to regenerate. When fully re-grown, the forest crop is clear-felled and new saplings planted. During the initial eight years, other forest products are taken to provide a source of income (Pham Trong Thinh 1997). These include aquatic fauna for food, *Melaleuca* oil (a valuable medicine), 'chaoi' *Stenochlaena palustris* (a plant used for making rope and fish nets), 'mop' *Alstonia spathulata* (a woody plant used for making fishing floats) and *Melaleuca* bark (used for thermal insulation).

Forests are an important economic resource in the Mekong Delta. Previously, large areas were covered in *Melaleuca* and mangrove forests, but wartime conflict devastated much of this, particularly due to the spraying of defoliants. More recently, the benefits of *Melaleuca* planting have been widely recognised, and the area of this forest type has increased in recent years. Mangrove has also been widely replanted, mainly in an effort to counteract shoreline erosion, which has resulted in the loss of valuable land along much of the eastern delta coastline and consequent saltwater inundation over large areas of rice-growing land.

Fisheries. Fish provide 40-60% of the protein in the diet of people living in the Mekong Delta (Pantulu 1986). Fishing is carried out almost everywhere, from the smallest canals to the largest river channels. In many of the major rivers, nets are placed across half the channel or more. Both fresh and saltwater species are fished for and a wide range of fishing methods used. Fish traps are widespread, the use of gill nets is frequent and more destructive methods, such as electro-fishing, are common.

Of the 260 species of fish known from the delta, 200 contribute to the commercial fishery (Le Dien Duc 1989). In addition, shellfish, mainly Mollusca and Crustacea, constitute an important element of the fishery. Fishery production has increased greatly, largely due to more intensive exploitation of existing resources, and Vietnam is now an important exporter of seafood. Fisheries also attract a considerable amount of foreign investment (e.g. 20 projects totalling US$55 million as of March 1999; Anon. 1999).

Two Mekong Delta provinces (Kien Giang and Ca Mau) are the biggest contributors to the fisheries sector in Vietnam. In Kien Giang, the bulk of the fishery consists of marine species, but in Ca Mau nearly half comes from inland fisheries. Between them, the 13 Mekong Delta provinces account for over half Vietnam's fishery production (Anon. 1994). The cultivation of seafood is a major income generator in coastal areas of the Mekong Delta, and constitutes 30% of the total fisheries production in Vietnam. Large areas of mangrove have been cleared to produce shrimp ponds in particular, and this has contributed to the increase in shoreline erosion noted above. However, in many areas the problems caused by conversion of mangrove to aquaculture and agriculture have been recognised, and extensive areas are now abandoned and being re-colonised by or replanted with mangrove species.

Hunting. The hunting of wildlife provides another source of protein as well as income to local people. While the levels of bird hunting using firearms appears to be low, trapping of waterbirds, particular crakes and rails is widespread. A range of other wildlife is commonly captured for food or to sell in local markets, including frogs, snakes, freshwater turtles and various rodents.

4. Methods

A combination of literature reviews, interviews and fieldwork were used to identify key sites for conservation in the Mekong Delta, over three project phases. In phase 1 all protected and unprotected wetlands that could be accessed were identified, mapped, and assessed using a rapid assessment approach. Phase 1 led to selection of key wetlands for biodiversity conservation to be included in phase 2, when detailed field studies were carried out and a general conservation strategy for each wetland developed. Phase 3 involved selecting from the key biodiversity conservation wetlands a few of the highest potential sites for potential protection under international, national, provincial, and/or local criteria.

4.1 Definition of study area

The Vietnam National Mekong Committee described the Mekong Delta to include the 11 southernmost provinces of the country (Vietnam National Mekong Committee 1998). Based on our knowledge of the distribution and conservation importance of wetlands in Long An province and Ho Chi Minh City we included those two administrative units within the scope of this study as well. Thus, the study area consisted of all lands within the 13 administrative units listed below.

- Ho Chi Minh City
- Long An province
- Tien Giang province
- Dong Thap province
- Ben Tre province
- Vinh Long province
- Tra Vinh province
- An Giang province
- Can Tho province
- Soc Trang province
- Kien Giang province
- Bac Lieu province
- Ca Mau province

4.2 Initial site selection

Literature review. To select sites of key biodiversity conservation importance the following studies conducted by others were consulted in addition to those carried out for this project:

- Vietnam National Wetland Conservation and Management Strategy (SIDA and IUCN);
- Inventory and Management of Wetlands in the Lower Mekong Basin (Mekong River Commission Environmental Programme Phase II);
- Coastal Wetlands Protection and Development Project (World Bank);
- Rehabilitation of Mekong Forests Project, Southern Mekong Delta;
- The Darwin *Melaleuca* Wetland Project (U.K. Dept. of Environment's Darwin Initiative);
- Marine and Coastal Resources Management (ADB);
- Mekong River Basin Wetland Biodiversity Conservation and Sustainable Use Programme (UNDP/GEF);
- MRC Programme for Fisheries Management and Development Cooperation (Mekong River Commission);
- Mekong River Commission agreement on the cooperation for the sustainable development of the Mekong River basin (MRCS);

- Draft Mekong work programme 1998 (MRCS); and
- 1999 work programme: from vision to action (MRCS).

Government and non-governmental organisation (NGO) liaison. Definition of the legal or administrative status of each of the wetland sites was carried out through liaison with government officials and NGOs. The aim was to assist in identification of any existing areas gazetted as protected areas at provincial level, or new areas proposed as national, provincial, district, or local protected areas.

Government liaison was carried out first at the national level through consultation with MoSTE and MARD in Hanoi, followed by consultation with the provincial MoSTE and MARD departments in each of the 13 administrative units of the study area.

Interviews with government and NGO representatives were structured to provide the following data:

- Is the current assessment of protected area status correct?
- Are decreed wetlands adequate in size, area of coverage, and management to ensure conservation of important biodiversity resources?
- If not, where are opportunities for expansion or change in the existing protected area system?
- Are there known but unprotected wetlands which are worthy of conservation?
- Are there development plans, which conflict with conservation at protected or unprotected wetlands?
- Can development plans be modified to enable biodiversity conservation (is there scope for sustainable development)?

4.3 Secondary site selection

Rapid assessment. Using the information gathered from the research and interviews described above, an initial rapid assessment phase involved visits to all wetlands sites identified in each province. The primary data recorded during the rapid assessment were presence of endangered, threatened or near-threatened bird species and numbers and species representation of waterbirds. Each wetland was visited once, and birds and other fauna identified to species where possible, counted, and recorded by habitat association. The objective of the rapid assessment was to cover the wetland as completely as possible and to determine whether the site supported fauna of special conservation interest or potential. Surveys also included assessments of the major habitats present at each site, in particular whether habitats of known conservation importance were present.

Criteria used for inclusion in second phase were:

- Presence of appreciable numbers of globally threatened or near-threatened bird species;
- Presence of large concentrations of birds indicative of wetland values e.g. large breeding colony, large concentrations of migratory shorebirds; and
- Presence of habitats indicative of high biodiversity, e.g. seasonally flooded semi-natural *Melaleuca* forest; seasonally inundated grasslands, mature mangrove forest; undisturbed mudflats.

Selection of key sites. Key biodiversity conservation sites were selected on the basis of the report review, rapid assessment, and ranking of wetlands undertaken in phase 1 above. In general the key sites were those:

- With highest existing or potential biodiversity;
- Supporting habitats of limited or declining spatial and geographic distribution;
- Supporting fauna of particular conservation concern (rare, endangered, threatened, near-threatened);
- Requiring lower inputs of capital or recurring expenditures to achieve effective biodiversity conservation; and
- With less threatening land use conflicts.

Ranking was based primarily on bird taxa, as birds are currently the most widely accepted indicators of wetland conservation importance and habitat quality: for example, the assessment criteria used under the Ramsar Convention primarily use waterbirds as indicators.

4.4 Evaluation of key sites

Field surveys provided much of the data used in evaluation of the key sites for conservation selected as a result of phase 1. Surveys were carried out during two fieldwork periods, from February to May and July to August 1999. Survey timings were designed to cover both dry and wet seasons: several bird species are dry season, winter or migratory visitors, while several waterbird species breed only in the wet season.

Habitat. Wetland types were classified according to Nguyen Van Nhan (1997) and type boundaries plotted on 1:50,000 maps of the wetland. A hand-held global positioning system (GPS) was used to plot wetland type boundaries. Satellite imagery was used in conjunction with field mapping to enhance the accuracy of the plotted wetland type boundaries and to produce the maps presented in chapter 6.

Vegetation. Vegetation was surveyed using 1 m quadrats placed arbitrarily in each different habitat type. The composition of the flora was recorded as species present, and the dominance assessed by the number of plants of each species in each quadrat. In areas of forest, the height and diameter at breast height (DBH) of each tree included in the quadrat were recorded to give mean values for each area.

Birds. Birds were surveyed using a combination of point counts and direct searching. Point counts provided data used to produce diversity indices comparable between sites. The aim of direct searching was to establish as complete a list as possible for each site and to locate rare species unlikely to be recorded during point counts. Surveys were carried out over 2 to 5 days in each season, depending on the size of the site and the variety of habitats present. All sites identified as priority sites were visited twice, once in the dry season (February-May) and once in the wet season (July-August). Some of the breeding colonies were only visited during the wet season, to coincide with the peak of breeding activity for most colonial nesters.

Point counts were made at each of the priority sites during the first phase of fieldwork. Due to access difficulties caused by high water levels it was often not possible to repeat point counts during the wet season, so only point counts from the dry season fieldwork were used to produce diversity indices. At

each site, point counts were made in the early morning (between dawn and 09h00) to coincide with peak bird activity. Habitat type was recorded at each point. All birds were counted and identified visually or aurally to species. Those individuals only seen flying over the sampling area were excluded unless they were aerial feeders (e.g. swallows *Hirundo* spp.).

Direct searching was carried out between sunrise and 11h00 and from 14h00 to sunset, though the times of observations varied depending on weather conditions. At coastal sites, searching aimed to coincide with the ideal stage of the tidal cycle to maximise potential numbers of birds using mudflats as roosting or feeding sites.

At colonies and roosts of large waterbirds, counts were made during the late afternoon at all sites. This is the period when the greatest numbers of individuals are present, as individuals returning to the colony to roost join birds remaining in the colony during the day. As most of the sites were large and difficult to access, counts were made of all birds present at the colony, rather than only of pairs or individual nests. Thus all numbers are of total birds present, including fledged young.

Other fauna. Mammals, fish, amphibians and reptiles were noted when encountered, but were not included in the site assessment process as they were infrequently seen, and a lack of sufficient literature precluded identification of most.

Water quality. To assess the acid-base status of surface water at wetland sites, pH was measured using a hand-held meter. This enabled an assessment of the likely severity of acidification caused by oxidation of acid-sulphate soils in and around wetland sites.

4.5 Criteria used in prioritisation of sites for conservation

In order to evaluate the relative biological and conservation value of the sites surveyed, a set of quantitative criteria was developed. This was based on criteria used in other projects with adaptation for this study. The main reference was Pederson and Nguyen Huy Thang (1996), who assessed relative importance of coastal sites in the Red River Delta of northern Vietnam. In turn, this was based on criteria for identification and selection of nature reserves in the U.K. (Ratcliffe 1977), for identification of wetlands of international importance (Ramsar Convention Bureau 1994) and for identifying globally threatened bird species (Collar *et al.* 1994). In this study, a total of 14 criteria were used in assessing the relative conservation importance of each site.

(i) Area (size or extent).
The relationship between habitat area and species richness is well known (Begon *et al.* 1996), with species richness generally increasing log-linearly with land area. Thus, we concluded that larger sites were likely to have a higher biodiversity value for all taxonomic groups than small sites. Sites were scored according to the following size classes: 0-9 ha = 1 point, 10-99 ha = 2, 100-999 ha = 3, 1,000-9,999 ha = 4 and 10,000+ ha = 5.

(ii) Diversity (species)
Four measures of bird diversity were used. Shannon's diversity index is a measure of both the number of species recorded and the relative abundance of each. This method requires standardised sampling so that valid comparisons can be made between sites. Therefore, for each point count made at each site, Shannon's diversity index was calculated and the mean for all point counts at each site calculated. Sites were then given scores according to this value as follows: 1-2 = 1 and 2-3 = 2.

Overall species richness was also used, this being the total number of species recorded during all the fieldwork at each site. For site scoring, an index was used whereby <40 species = 1, 40-59 species = 2, 60-79 species = 3 and 80+ species = 4.

Comparisons of species diversity should not just involve a straightforward measurement of the a, or within-sites diversity, but also a measure of the ß, or between-sites diversity. For example, if two sites with similar diversity indices involve the same range of species, the ß diversity is zero, whereas if there is no species overlap the ß diversity is high. The degree of similarity of sites was therefore measured using Sorensen's index, which is calculated by comparing the total species lists for each site pair and the number of species common to both. For each possible site-pair, Sorensen's Index was calculated and the mean for each site over all species pairs used in the site assessment. Higher scores reflect lower ß diversity and were therefore scored as follows: 5+ = 1 point, 4.0-4.99 = 2, and 3.0-3.99 = 3.

A further measure of avian diversity used was 'taxonomic relatedness'. This is a measure of diversity over all taxonomic levels, not just species level. For example, a site which held 10 species all of the same genus would be considered to have lower diversity than a site which held 10 species from 10 different genera. A methodology now exists which allows this index to be calculated regardless of differences in sampling effort between sites, as long as a reasonably complete list of species is available for each (Clarke and Warwick 1998; Warwick and Clarke 1998). Taxonomic relatedness of the Mekong Delta avifauna as a whole was also calculated, and sites scored 1 point if their value exceeded this with no point awarded if it fell below.

(iii) Diversity (habitats)
The number of habitats as defined by Nguyen Van Nhan (1997) was used as an indication of habitat diversity for each site. Sites with 1-2 habitats scored 1 point, 3-4 habitats scored 2, 5-6 habitats scored 3, and 7 or more habitats scored 4 points.

(iv) Rarity (species)
The occurrence of any bird species listed as globally threatened or near-threatened by Collar *et al.* (1994) was used as a measure of the importance of a site in supporting rare bird species. The score given for each species depended on its threat category: 1 point for 'near threatened' (NT), 2 points for 'vulnerable' (VU), 3 for 'endangered' (EN) and 4 for 'critical', though no critically threatened species were recorded.

(v) Rarity (habitat)
The presence of certain rare habitats at any site was used as an indicator of the conservation importance of the site. Habitats that were found to be rare in the delta were seasonally inundated grassland, mature semi-natural *Melaleuca* forests, *Melaleuca* swamp along a natural river course, mature semi-natural mangrove, and extensive undisturbed mudflats. Presence of each of these habitats merited a score of 1 point.

(vi) Species congregation (species population concentration)
For any species or subspecies represented by 1% or more of its global or regional population, a score of 1 point was awarded. To further emphasise the conservation importance of wetlands supporting large portions of global species populations a score of 5 points was awarded for each wetland supporting 5% or more of the global population of any bird species or subspecies. Data for calculating the 1% and 5% population levels of species and subspecies came from Wetlands International.

(vii) Naturalness
Naturalness of habitats is often a rare condition in countries or areas with high human population density, and habitats least modified by anthropogenic activity should therefore be priorities for conservation action. Although it is unlikely that any habitats in the Mekong Delta remain in their truly natural state, three habitat types were at least semi-natural in character: seasonally inundated grassland, mature semi-natural mangrove forest, and mature semi-natural *Melaleuca* forest. Sites scored 1 point for the presence of each of these.

(viii) Fragility
This is an indication of the degree of sensitivity of habitats, communities and species to environmental change and human impacts. Certain landscape forms and plant and animal communities are particularly sensitive to anthropogenic activities and protection of such features is therefore deemed to be especially important. Such habitats include seasonally inundated grassland, and the presence of this habitat at a site therefore merited a score of 1 point.

(ix) Special role in maintaining biological diversity
Sites with certain attributes of their flora and fauna have a special value in maintaining genetic and biological diversity of a region. Where a species is only recorded at one site, that site could be determined to be essential to the species concerned. Therefore, where a bird species was recorded at only one site, 1 point was awarded to the site where it occurred. To allow for the stochasticity in distribution of some species, only those species that were resident or were known to be winter visitors were included in this analysis.

(x) Position as an ecological unit
A small site surrounded by agricultural land is likely to be less valuable in the long term than a site contiguous with other natural or semi-natural habitats. This reflects the tendency for isolated populations of species to be more vulnerable to extinction and the likelihood that pressures from surrounding land use will have detrimental impacts on isolated sites. The importance of conserving as many as possible of the important and characteristic formations, communities and species of an area is also recognised. Sites that were contiguous with another area of natural or semi-natural habitat therefore scored 1 point.

(xi) Conservation management potential
Scores from 1 to 3 points were given to each site based on the potential for corrective management to transform an unsustainable situation into one that promotes wetland biodiversity conservation inexpensively, quickly, and effectively.

(xii) Potential education and cultural value
Sites that present unique opportunities for environmental education or tourism, such as special landscape features and historical or cultural sites scored 1 point.

(xiii) Conservation momentum
A score of 1 point was awarded for wetlands that have attracted government conservation support, but are not yet officially protected. In such cases the wetland may have the potential to be quickly added to the conservation network.

(xiv) Conservation value
In recognition of the existing degree of political will to protect a site, those which had already been designated or proposed as a protected area, or were subject to restricted access or land use for biodiversity conservation reasons, were given a score of 1 point.

5. Results

5.1 Site classification

Twenty nine sites in the 13 Mekong Delta administrative units were located and visited as part of the rapid assessment process (Table 1; Fig. 1). Sites fell into one of three major categories: coastal (predominantly saltwater) sites, inland (predominantly freshwater) sites and non-wetland bird colonies. Of these, 10 from the first two categories were selected as key sites for further study on the basis of the criteria outlined above (Table 2), two of which were coastal sites and eight inland sites. Although some wetland sites included within them important bird colonies, seven sites were bird colonies that did not constitute important wetland habitat. These sites were therefore assessed separately (see below).

Table 1: Full list of sites in the Mekong Delta visited during the rapid assessment phase.

Site	Province	Type	Main features of interest	RAC
Vo Doi Nature Reserve	Ca Mau	Inland	*Melaleuca* forest and grassland	3
Bai Boi	Ca Mau	Coastal	Mudflats, migratory waterbirds	1,2,3
Dat Mui Nature Reserve	Ca Mau	Coastal	Mudflats, migratory waterbirds	1,2,3
Dam Doi Nature Reserve	Ca Mau	Coastal	Degraded mangrove	
Ca Mau Bird Sanctuary	Ca Mau	Colony	Large bird colony	2
Ha Tien	Kien Giang	Inland	Grassland, threatened waterbirds	1,3
U Minh Thuong Nature Reserve	Kien Giang	Inland	*Melaleuca* forest and grassland, large colony	1,2,3
Tra Su	An Giang	Inland	*Melaleuca* plantation, grassland and colony	2,3
Tinh Doi	An Giang	Inland	*Melaleuca* plantation and grassland	3
Binh Minh	An Giang	Inland	*Melaleuca* plantation	
Bac Lieu Nature Reserve	Bac Lieu	Colony	Large bird colony	2
Lung Ngoc Hoang	Can Tho	Inland	*Melaleuca* plantation and grassland	3
Hoa An	Can Tho	Inland	Experimental plots of *Melaleuca* and rice	
Thoi An	Can Tho	Colony	Large colony	2
Tram Chim National Park	Dong Thap	Inland	Grassland, threatened waterbirds	1,2,3
Xeo Quyt	Dong Thap	Inland	*Melaleuca* forest, cultural significance	
Lang Sen	Long An	Inland	Riverine *Melaleuca* forest	3
Bau Bien	Long An	Inland	Open swamp	
Tra Cu	Tra Vinh	Colony	Large colony	1,2
Duyen Hai Mangrove	Tra Vinh	Coastal	Semi-natural *Sonneratia* mangrove	
Duyen Hai Bird Sanctuary	Tra Vinh	Colony	Large colony	2
Chua Hang Bird Sanctuary	Tra Vinh	Colony	Large colony	2
Thanh Phu	Ben Tre	Coastal	Plantation mangrove	
Vam Ho	Ben Tre	Colony	Large colony	2
Bao Thuan	Ben Tre	Coastal	Plantation mangrove	
Can Gio	HCM City	Coastal	Mature mangrove plantation	
Tan Phuoc	Tien Giang	Inland	Small area of *Melaleuca* and grassland	
Go Cong Dong	Tien Giang	Coastal	Plantation mangrove	
Long Phu	Soc Trang	Coastal	Plantation mangrove	

'RAC' refers to the rapid assessment criteria met by each site (if any) to merit inclusion in the second phase of site evaluation. 1 = presence of appreciable numbers of globally threatened or near threatened bird species; 2 = presence of large concentrations of species indicative of wetland values; 3 = presence of habitats of high biodiversity value.

Figure 1. Map of the Mekong Delta indicating site locations

Inland wetlands. Inland wetlands were dominated by *Melaleuca* plantations and seasonally inundated grassland. *Melaleuca* forest varied from dense, commercial plantations with little biodiversity value, to mature semi-natural forest with a high diversity of plants and birds. Seasonally inundated grassland included several subtypes, including dense *Phragmites vallatoria*-dominated grassland and more open *Eleocharis*-dominated habitats. Several globally threatened and near-threatened species were recorded in these habitats (Table 2).

Table 2: Globally threatened and near-threatened bird species recorded in inland wetlands of the Mekong Delta. Threat categories follow Collar *et al.* (1994)

English name	Scientific name	Threat category
Bengal Florican	*Houbaropsis bengalensis*	Endangered
Sarus Crane	*Grus antigone*	Near-threatened
Oriental Darter	*Anhinga melanogaster*	Near-threatened
Black-headed Ibis	*Threskiornis melanocephalus*,	Near-threatened
White-shouldered Ibis	*Pseudibis davisoni*	Endangered
Spot-billed Pelican	*Pelecanus philippensis*	Vulnerable
Painted Stork	*Mycteria leucocephala*	Near-threatened
Asian Openbill	*Anastomus oscitans*	Near-threatened
Lesser Adjutant	*Leptoptilos javanicus*	Vulnerable
Asian Golden Weaver	*Ploceus hypoxanthus*	Near-threatened

Coastal wetlands. Coastal wetlands were dominated by mangrove forest, the vast majority of which was plantation. Some areas also had some naturally regenerating mangrove but very little mature natural mangrove was found to remain at the sites visited. Two sites (Duyen Hai in Tra Vinh province and Can Gio in Ho Chi Minh City) had mature semi-natural mangrove, though in both cases this was secondary growth. Some sites supported large concentrations of migratory waterbirds, including several globally threatened and near-threatened species (Table 3).

Table 3: Globally threatened and near-threatened bird species recorded in coastal wetlands of the Mekong Delta. Threat categories follow Collar *et al.* (1994)

English name	Scientific name	Threat category
Eastern Curlew	*Numenius madagascariensis*	Near-threatened
Asian Dowitcher	*Limnodromus semipalmatus*	Near-threatened
Grey-headed Lapwing	*Vanellus cinereus*	Near-threatened
Chinese Egret	*Egretta eulophotes*	Endangered
Black-headed Ibis	*Threskiornis melanocephalus*	Near-threatened
Spot-billed Pelican	*Pelecanus philippensis*	Vulnerable
Painted Stork	*Mycteria leucocephala*	Near-threatened

Bird colonies. Many bird colonies were not strictly wetlands, in that they did not always consist of wetland habitats. Nevertheless they perform a vital wetland *function* in providing breeding grounds for large numbers of waterbirds (Table 4). Colonies were assessed according to the relevant criteria outlined above, i.e. according to the presence of significant populations of wetland birds, or presence of globally threatened or near-threatened bird species.

Table 4: Numbers of waterbirds recorded at each of 10 colonies and/or roost sites in the Mekong Delta, February-August 1999.

English name	Scientific name	Bac Lieu		Tra Cu		U Minh Thuong		Tra Su		Vam Ho	Thoi An	Chua Hang	Ca Mau	Bai Boi	Duyen Hai	Total
		Mar	Aug	Feb	Jul	May	Aug	Apr	Jul	Jul	Jul	Jul	Aug	Mar	Feb	
Cotton Pygmy-goose	*Nettapus coromandelianus*		2													2
Oriental Darter	*Anhinga melanogaster*		1					1	3			5	1			9
Little Cormorant	*Phalacrocorax niger*	200	700	200	400	1,063	900	50	650	50	300		1,500	103	200	4,966
Indian Cormorant	*Phalacrocorax fuscicollis*	2	930						5							930
Little Egret	*Egretta garzetta*	100	304	300	1,600	1,581	82	750	150	300	1,000	1,200	1,500	416	1,500	10,150
Pacific Reef Egret	*Egretta sacra*									1						1
Grey Heron	*Ardea cinerea*	20	42			10	5	16	8	1						69
Purple Heron	*Ardea purpurea*	25	140			152	75	10	317						1	610
Great Egret	*Casmerodius albus*	25	70	30	50	125			5				2	12	100	364
Cattle Egret	*Bubulcus ibis*		650	700	500	1,242	86	1,750	1,000	300	2,000	1,200	1,000		300	9,142
Chinese Pond Heron	*Ardeola bacchus*	5				4								2		11
Javan Pond Heron	*Ardeola speciosa*		9		11	5	17		2	6			11			56
Little Heron	*Butorides striatus*		2													2
Black-crowned Night Heron	*Nycticorax nycticorax*	3	700	300	1,600	5		33	280	350		1,200	150			4,285
Yellow Bittern	*Ixobrychus sinensis*		2						1		2					5
Cinnamon Bittern	*Ixobrychus cinnamomeus*									2						2
Black Bittern	*Dupetor flavicollis*		6			2	23									29
Glossy Ibis	*Plegadis falcinellus*		59	300	10	1,391						5	2			1,757
Black-headed Ibis	*Threskiornis melanocephalus*		4	50	50	12										66
Asian Openbill	*Anastomus oscitans*					73	5									73
Total (maximum)		3,626		4,711		5,698		3,779		1,010	3,302	3,610	4,166	533	2,101	32,536

5.2 Habitats

Eighteen habitat types as defined by Nguyen Van Nhan (1997) were recorded (Table 5). Perennial rivers or canals were recorded at almost all sites. *Melaleuca* forest was recorded at 12 sites, including two sites with a permanent *Melaleuca* forest reservoir. Sixteen sites had some sort of rice cultivation occurring within their boundaries, though often in a buffer zone.

Table 5: Wetland habitats recorded at 29 sites in the Mekong Delta. Habitat types and codes follow the classification given in Nguyen Van Nhan (1997).

Type	Code	Habitat	Number of sites
Marine/coastal	2	Coastal mudflat	6
	3	Coastal aquaculture	5
	4	Coastal mangrove plantation	8
	7	Coastal wet rice	5
	9	Coastal non-tidal grassland	4
Estuarine	13	Estuarine mudflat	1
	14	Estuarine salt works	1
	15	Estuarine aquaculture	1
	16	Estuarine mangrove plantation	6
Riverine	24	Perennial river and canal	27
	26	Floodplain grassland	8
	27	Floodplain wet rice	9
	30	Floodplain other crops	4
	31	Seasonally flooded *Melaleuca* plantation	10
Lacustrine	33	Permanent *Melaleuca* forest reservoir	2
Palustrine	35	Seasonally flooded grassland	2
	36	Seasonally flooded *Melaleuca* plantation	3
	37	Seasonally flooded wet rice	2

This habitat classification was used as a standard to assess habitat diversity at sites, but for mapping purposes, habitats were subdivided to reflect habitat gradations (e.g. grassland with *Melaleuca* scrub) and variations (e.g. mature as opposed to young plantation *Melaleuca*) within the habitat definitions given by Nhan (1997). At the 10 priority sites, habitat types were mapped in MapInfo GIS and areas in hectares of broad habitat types at each site were calculated (Table 6).

Table 6: Areas of 11 broad habitat types at 10 priority wetland sites in the Mekong Delta.

Habitat type	Area (ha)										
	Bai Boi	Dat Mui	Lung Ngoc Hoang	Vo Doi	U Minh Thuong	Ha Tien	Tra Su	Tinh Doi	Tram Chim	Lang Sen	Total
Mangrove plantation	2,344	3,077									5,421
Regenerating mangrove	748	1,134									1,882
Old growth mangrove		771									771
Mudflat	1,504	1,050									2,554
Aquaculture	646	720									1,366
Nypa fruticans swamp						519					519
Settlement and agriculture	283	486	1,022	2,012	12,140	2,101	47	154	557	2,225	21,027
Open swamp			222	727	1,019		90	20	520	23	2,621
Grassland					1,721	8,509	85	379	3,609		14,303
Grassland with *Melaleuca*			429	1,872	1,606	71	71	510	955		5,514
Melaleuca plantation			1,040	5,500	2,309	3,188	568	581	2,099	970	16,255
Mature *Melaleuca* forest	881	4,123					62	5,066			
Total (ha)	**5,525**	**7,238**	**2,713**	**10,992**	**22,918**	**14,388**	**861**	**1,644**	**7,740**	**3,280**	**77,299**

5.3 Birds

A total of 194 species of birds were recorded during the survey work (Appendix 2). Of these, 73 were 'waterfowl' under the definition given the Ramsar Convention, but a further 27 species could be described as wetland-dependent (including several kingfisher species and wetland-dependent passerines such as reed warblers *Acrocephalus* spp.). Thus, over half (100 species) were strongly associated with wetlands. Almost one third (61 species) were strictly migrants to the delta, including most of the shorebirds recorded. Most of these were non-breeding visitors that breed outside of Vietnam. Fourteen globally threatened or near-threatened species were recorded during the survey work (Collar *et al.* 1994; Tables 2 and 3), of which three are classed as endangered, two as vulnerable and nine as near-threatened.

The Mekong Delta provides habitat for a significant proportion of the regional or global population of several species (Table 7). Most notably, over 10% of the South-East Asian populations of Glossy Ibis *Plegadis falcinellus*, Little Egret *Egretta garzetta* and Cattle Egret *Bubulcus ibis*, 3% of the world population of Indian Cormorant *Phalacrocorax fuscicollis*, and 6% of the South-East Asian population of Purple Heron *Ardea purpurea* were recorded. At Bai Boi and Dat Mui up to 0.8% of the world population of endangered Chinese Egret and up to 1.1% of the near-threatened Asian Dowitcher were recorded. As access at these sites was difficult, and allowing for site turnover, it is likely that these are underestimates and that the sites support >1% of the global population of both species.

For several widespread species it is likely that the Mekong Delta provides important habitat for significant proportions of their regional populations, even if the numbers recorded during site visits did not exceed 1% of the estimated regional population. For example, the minimum estimates of the South-East Asian populations of Spot-billed Duck *Anas poecilorhyncha* (subspecies *poecilorhyncha*), Chinese Pond Heron *Ardeola bacchus*, Black Bittern *Dupetor flavicollis* and Oriental Pratincole *Glareola maldivarum* are each less than 70,000, and each species is common outside the natural and semi-natural sites visited in this study. The Mekong Delta populations of each species is therefore likely to constitute >1% of its South-East Asian regional population.

The passerine avifauna of the delta was species poor. Most species recorded are common and widespread throughout much of Asia, and only two species of conservation interest were recorded, the globally near-threatened Asian Golden Weaver, and Large-billed Crow *Corvus macrorhynchos*, which is believed to be vulnerable to human pressure (Duckworth *et al.* in press) and is very scarce in the Mekong Delta (pers. obs.). Particularly common and widespread resident species included Golden-bellied Gerygone *Gerygone sulphurea*, Pied Fantail *Rhipidura javanica*, Common Iora *Aegithina tiphia*, Oriental Magpie Robin *Copsychus saularis*, Oriental White-eye *Zosterops palpebrosus* and Olive-backed Sunbird *Nectarinia jugularis*. Several winter visitors were recorded, the commonest being Brown Shrike *Lanius cristatus*, Black Drongo *Dicrurus macrocercus* and Oriental Reed Warbler *Acrocephalus orientalis*. Wetland-dependent passerines included Oriental Reed Warbler, Black-browed Reed Warbler *Acrocephalus bistrigiceps*, Rusty-rumped Warbler *Locustella certhiola* and Zitting Cisticola *Cisticola juncidis*. Very few species typical of terrestrial forest were found: those recorded (e.g. Scarlet Minivet *Pericrocotus flammeus* and Indochinese Cuckoo-shrike *Coracina polioptera*) were restricted to mature *Melaleuca* forest (e.g. Vo Doi, U Minh Thuong), or areas of woodland found within a site (e.g. Bac Lieu, Xeo Quyt).

Habitat associations. The number of species recorded in each of four main habitat categories gives an indication of the relative importance of each to biodiversity conservation. Bird species richness was highest in seasonally inundated grassland and swamps (100 species), while anthropogenic habitats (including paddyfields, aquacultural ponds and villages) had the lowest richness (83 species). *Melaleuca* forest also held a large number of species, almost as many as grassland and swamp (97 species; Table 8).

Table 7: Bird species and subspecies for which the Mekong Delta is likely to support 1% or more of the global or regional population.

English name	Scientific name	Population (species or subspecies)	Estimate of global or regional popn*	Mekong Delta popn.†	% of popn.	Site max.	% of popn.
Spot-billed Duck	*Anas poecilorhyncha*	S Asian *poecilorhyncha*	50,000	376	0.8	202	0.4
Sarus Crane	*Grus antigone*	Indochina *sharpii*	500-1,500	338	22.5-67.6	203	13.5-40.6
Whimbrel	*Numenius phaeopus*	SE Asian *variegatus*	40,000	168	0.4	106	0.3
Eurasian Curlew	*Numenius arquata*	E/SE Asian *orientalis*	10,000-100,000	416	0.4-4.2	363	0.4-3.6
Asian Dowitcher	*Limnodromus semipalmatus*	World	15,000-20,000	160	0.8-1.1	144	0.72-0.95
Black-winged Stilt	*Himantopus himantopus*	SE Asian *himantopus*	10,000-100,000	72	0.07-0.7	22	0.02-0.2
Grey-headed Lapwing	*Vanellus cinereus*	World	10,000-100,000	10	0.01-0.1	8	0.01-0.08
Oriental Pratincole	*Glareola maldivarum*	E/SE Asian breeding	67,000	109	0.2	50	0.07
Caspian Tern	*Sterna caspia*	E/SE Asian *caspia*	10,000-25,000	250	1.0-2.5	209	0.8-2.1
Little Cormorant	*Phalacrocorax niger*	S Asian	150,000	5,017	3.3	1,500	1
Indian Cormorant	*Phalacrocorax fuscicollis*	World	30,000	937	3.1	930	3.1
Little Egret	*Egretta garzetta*	SE Asian *garzetta*	100,000-1,000,000	10,402	1.0-10.4	1,600	0.2-1.6
Chinese Egret	*Egretta eulophotes*	World	1,800-2,500	15	0.6-0.8	9	0.5
Purple Heron	*Ardea purpurea*	SE Asian *manilensis*	10,000-100,000	618	0.6-6.2	319	0.3-3.2
Great Egret	*Casmerodius alba*	E Asian *modestus*, migratory	10,000-100,000	470	0.5-4.7	125	0.1-1.3
		S Asian *modestus*, resident	25,000	470	1.9	125	0.5
Cattle Egret	*Bubulcus ibis*	E/SE Asian *coromandus*	100,000-1,000,000	10,084	1.0-10.1	2,500	0.3-2.5
Chinese Pond Heron	*Ardeola bacchus*	World	25,000-1,000,000	236	0.02-0.9	102	0.01-0.4
Javan Pond Heron	*Ardeola speciosa*	Mainland SE Asian *continentalis*	10,000-100,000	77	0.08-0.8	17	0.02-0.2
Black Bittern	*Dupetor flavicollis*	E/SE Asian *flavicollis*	10,000-100,000	54	0.05-0.5	23	0.02-0.2
Glossy Ibis	*Plegadis falcinellus*	SE Asian *falcinellus*	15,000-25,000	1,757	7.0-11.7	1,391	5.6-9.3
		SE Asian/Australian *peregrinus*	25,000-1,000,000	1,757	0.2-7.0	1,391	0.1-5.6
Black-headed Ibis	*Threskiornis melanocephalus*	SE Asian	10,000-25,000	129	0.5-1.3	63	0.2-0.6
Painted Stork	*Mycteria leucocephala*	SE Asian	<10,000	109	>1.1	96	>1.0
Woolly-necked Stork	*Ciconia episcopus*	SE Asian *neglecta*	<10,000	10	>0.1	8	>0.08

* estimates from Wetlands International.

† minimum population in Mekong Delta estimated by this study.

Of the 14 globally threatened or near-threatened species recorded, nine were recorded in seasonally inundated grasslands and swamps, and only three were recorded in anthropogenic habitats (Grey-headed Lapwing, Spot-billed Pelican and Painted Stork). A flock of eight Grey-headed Lapwings was found in the experimental paddyfields of Hoa An Research Station, where disturbance is minimal. The latter two species were found in paddyfields which were currently flooded and not under cultivation. The high number of threatened species recorded in mangroves and mudflats emphasises the importance of these sites for migratory waterbirds.

Table 8: Number of species associated with each of four habitat classifications from surveys carried out in the Mekong Delta, 1999.

	Agricultural and urban	Mangrove and mudflats	Seasonally inundated grassland and swamp	*Melaleuca* forest
Number of species recorded	83	92	100	97
Number of globally threatened species	3	7	9	4

5.4 Mammals, reptiles and amphibians

Mammals, reptiles and amphibians were infrequently recorded during the surveys. Those that were are noted below under the site descriptions. No evidence was found of the continuing existence of dolphins or crocodiles in the waterways of the Mekong Delta: although no specific effort was made to search for these, there was no anecdotal evidence to suggest otherwise. Anecdotal reports did suggest, however, that otters *Lutra, Lutragale, Aonyx* spp. remain at a few sites. It is likely that Sambar survives in the remaining extensive areas of *Melaleuca* forest in the U Minh wetlands (see chapter 6 below).

6. Site descriptions

Based on the rapid assessment exercise, 10 sites were selected for more detailed surveys. Each of these is described below together with the justification of the scoring given under each of the evaluation criteria used.

6.1 Lung Ngoc Hoang

General description. Lung Ngoc Hoang (9°41'-9°45'N 105°39'-105°43'E; Map 1) is situated in Phung Hiep district, Can Tho province. The site covers c. 2,713 ha including c. 1,040 ha of *Melaleuca* plantation. Several small patches of open swamp and grassland with *Melaleuca* scrub constitute c. 640 ha in total. Approximately one third of the area is cultivated with rice and sugar cane. An extensive network of canals runs throughout the site.

Most of the *Melaleuca* forest is commercial plantation with little biodiversity value. The remaining areas of swamp are of greater interest, although much is now planted with *Melaleuca* saplings. Measurements of pH were between 7.5 and 7.7, suggesting that within the site there is not a serious acidification problem.

Status. Lung Ngoc Hoang is a commercial Production Forest. However, provincial authorities have proposed it as a nature reserve. The management authority is the provincial MARD.

Flora. The main vegetation at this site consisted of *Melaleuca* plantation. Canopy height in areas of mature plantation was typically 8 m, with estimated canopy coverage of 75%. Tree density was 1.2 m^{-2} and mean DBH 9.4 cm. Medium aged (five years old) plantation typically had 2 trees m^{-2}, with a mean height of 5.7 m, mean DBH of 4.3 cm, and estimated canopy coverage of 75%. Young plantations were densest, having 4.5 trees m^{-2} and a mean height of just 1.1 m. The ground layer in areas of *Melaleuca* plantation was often rather sparse, but included herbaceous species of Cyperaceae and Poaceae.

Areas of grassland included some large areas of *Eleocharis dulcis* meadow, associated with which were *Cynodon dactylon*, and patches of naturally regenerating *Melaleuca*. *Ipomoea aquatica*, *Eichhornia crassipes*, *Ludwidgia adscendens* and *Centrostachys aquatica* were also present.

Three other grassland types were found. *Scleria poaeformis* meadow included some *Eleocharis dulcis* and other species from the Poaceae. *Hymenachne acutigluma* meadow was dominant along some canal banks, with *Cyperus malaccensis*, *Ipomoea aquatica*, *Eichhornia crassipes*, *Ludwidgia adscendens*, *Centrostachys aquatica*, and *Vigna luteola* also occurring. Occasional patches of tall (2-3 m), dense *Phragmites vallatoria* meadow were also found.

The aquatic plant community of canals frequently included *Eichhornia crassipes*, *Pistia stratiotes*, *Salvinia cucullata*, *Ipomoea aquatica*, *Ludwidgia adscendens*, *Centrostachys aquatica*, *Azolla pinnata*, *Spirodela polyrrhiza*, and *Lemna aequinoxialis*. *Hymenachne acutigluma*, *Coix aquatica*, *Phragmites vallatoria, Vigna luteola* and *Cayratia trifolia* were also recorded here.

Birds. The diversity of wetland birds was low, with only 50 species being recorded during the four days of fieldwork covering both wet and dry seasons. No globally threatened or near-threatened species were found. Most large wetland birds were scarce, with very few egrets or herons being recorded in the dry season. In the wet season more wetland species were recorded, including Bronze-winged Jacana *Metopidius indicus* (one) and Black Bittern (several). The avifauna of the *Melaleuca* plantation areas was limited, consisting mainly of Pied Fantails, Olive-backed Sunbirds and Oriental White-eyes.

No significant records of other fauna were made.

Threats and conservation recommendations. The following threats to biodiversity conservation were identified:

- *Melaleuca* at the site is still commercially harvested resulting in high levels of disturbance throughout the site, which may explain the scarcity of wetland birds; and
- Anecdotal reports suggested that people in surrounding areas of rice agriculture deliberately poison birds using treated bait. This may also be a causative factor influencing bird abundance within the site.

Based on our findings, there is potential for the biodiversity value of this site to be considerably enhanced. We recommend the following action:

- Cessation of further planting of *Melaleuca* in areas of grassland and open swamp;
- *Melaleuca* planting to be confined to replacement in areas that have been harvested;
- Establishment of strictly protected zones coinciding with the remaining areas of open swamp and grassland, to reduce disturbance and potential hunting pressure;
- Establishment of a finance scheme whereby profits arising from commercial exploitation of *Melaleuca* are used to support activities necessary for establishing a nature reserve; and
- An investigation into the practice of poisoning birds in surrounding agricultural land.

Criteria scores for Lung Ngoc Hoang.

Area 2,713 ha — Score: 4

Diversity (species).
Shannon's Diversity Index: 1.617 — Score: 1
Species richness: 50 species — Score: 3
Uniqueness: 5.005 — Score: 1
Taxonomic relatedness: 3.986 — Score: 1

Diversity (habitats). Five habitats recorded. — Score: 3

Rarity (species). None. — Score: 0

Rarity (habitats). Seasonally inundated grassland. — Score: 1

Species congregation. None. — Score: 0

Naturalness. Seasonally inundated grassland. — Score: 1

Fragility. Seasonally inundated grassland. — Score: 1

Special role in maintaining biological diversity. No bird species were confined to this site. — Score: 0

Position as an ecological unit. Surrounded by agricultural land. Score: 0

Conservation management potential. Given the heavy use exploitation of forestry and the associated high population density within the site, it seems unlikely that changing the situation into a sustainable one will be inexpensive, quick or effective. Score: 1

Potential education and cultural value. None. Score: 0

Conservation momentum. Not officially protected, but some interest on the part of provincial authorities to establish a nature reserve. Score: 1

Conservation value. Not yet a protected area. Score: 0

Total Score: 18
Ranking: 10

6.2 Bai Boi

General description. Bai Boi (8°38'-8°47'N 104°45'-104°54'E; Map 2) is a coastal site on the Ca Mau peninsular covering some 5,525 ha. It comprises a series of abandoned aquaculture ponds, which are being re-colonised by mangrove, and extensive accreting mudflats with naturally regenerating mangrove. Two islands (Con Trong and Con Ngoai) have formed due to accretion in the mouth of the main river.

Status. Bai Boi is classed as coastal Protection Forest, the aim of which is to prevent coastal erosion and to provide protection for areas inland from severe weather conditions. The boundary of the site is defined as the seaward edge of the mudflat, hence this boundary will shift as the mudflat accretes and the site area will increase. The official site area is 8,555 ha, but maps available on site suggest an area of 5,525 ha. However, the exact extent of the site is difficult to determine due to the high accretion rates. The management authority is the provincial FPD.

Flora. Mangrove forest on the accreting tidal mudflats was dominated by *Avicennia* spp. in different successional stages; young mangrove on the newly emerged mudflats to medium age and mature mangrove on the landward side. Tree density was highest further inland, with up to 3 trees m^{-2} in places.

On the islands at the river mouth the main vegetation type was a mixture of *Rhizophora* and *Avicennia* mangrove. Where the deposited mud was still new and soft, *Avicennia* spp. (including *A. marina*, and *A. alba*) were dominant with only scattered young *Rhizophora apiculata* (1.5-2 m height). Further from the island edges, the dominance of *Avicennia* gradually decreased and the proportion of *Rhizophora* increased, so that in some areas their populations were roughly equal. The tallest *Avicennia* trees in this area were 7 m in height with a DBH of 25 cm; the tallest *Rhizophora* trees were 5 m tall with a DBH of 7 cm.

Birds. The complex of mudflats and areas of open regenerating mangrove provided excellent habitat for migratory shorebirds, herons, egrets, gulls and terns (Table 9). In March, 12 species of shorebirds were recorded, and although numbers recorded were low (60 Whimbrel *Numenius phaeopus* was the highest species count) these are not likely to accurately reflect the numbers using the site, as access to large areas was not possible. Of particular note were five Chinese Egrets (endangered), 16 Asian Dowitchers and six Eastern Curlews (both near-threatened). Whiskered *Chlidonias hybridus* and Caspian Terns *Sterna caspia* were also recorded in good numbers, with 201 of the former counted on 24 March 1999.

In August, numbers of migratory shorebirds recorded were lower, possibly due to the stage of the tidal cycle which meant that the mudflats were under water for most of the daylight hours. Nevertheless, small numbers of seven species were recorded, together with a single Painted Stork.

Table 9: Maximum counts of shorebirds, gulls and terns from Bai Boi and Dat Mui, Ca Mau province, in March and August 1999.

English name	Scientific name	Bai Boi		Dat Mui	
		March	August	March	August
Black-tailed Godwit	*Limosa limosa*	1			30
Bar-tailed Godwit	*Limosa lapponica*	7	15		
Whimbrel	*Numenius phaeopus*	60	1	6	100
Eurasian Curlew	*Numenius arquata*	27	26	41	322
Eastern Curlew	*Numenius madagascariensis*	4		2	1
Common Redshank	*Tringa totanus*	12	8		59
Marsh Sandpiper	*Tringa stagnatilis*	12			3
Common Greenshank	*Tringa nebularia*	31	8	80	60
Wood Sandpiper	*Tringa glareola*				20
Terek Sandpiper	*Xenus cinereus*	2			
Common Sandpiper	*Actitis hypoleucos*		2	2	16
Grey-tailed Tattler	*Heteroscelus brevipes*				2
Ruddy Turnstone	*Arenaria interpres*				2
Asian Dowitcher	*Limnodromus semipalmatus*	16			144
Curlew Sandpiper	*Calidris ferruginea*				82
Black-winged Stilt	*Himantopus himantopus*				15
Pacific Golden Plover	*Pluvialis fulva*	5			5
Grey Plover	*Pluvialis squatarola*	34		5	2
Lesser Sand Plover	*Charadrius mongolus*			1	68
Greater Sand Plover	*Charadrius leschenaultii*				2
Grey-headed Lapwing	*Vanellus cinereus*			1	
Oriental Pratincole	*Glareola maldivarum*		10		
Brown-headed Gull	*Larus brunnicephalus*	37		27	
Caspian Tern	*Sterna caspia*	36		209	
Common Tern	*Sterna hirundo*		3		
Whiskered Tern	*Chlidonias hybridus*	201		355	
Total		**485**	**73**	**729**	**933**

The mangrove bird community was dominated by common mangrove species, including Ashy Tailorbird *Orthotomus ruficeps*, Golden-bellied Gerygone, Oriental White-eye and Pied Fantail. Several Brahminy Kites *Haliastur indus* were recorded during both visits (up to six a day), which is noteworthy because the species has declined throughout much of its range in South-East Asia (Lekagul and Round 1991; van Balen *et al*. 1993; Thewlis *et al*. 1998).

A roost of egrets and Little Cormorants *Phalacrocorax niger* on the outer of the two rivermouth islands was counted on 23 March 1999, and comprised over a thousand birds (Table 4), but no breeding activity was recorded here and few birds were using the roost in August.

Threats and conservation recommendations. Currently, human use of the site is low. Small numbers of fisherman were seen on site, and little exploitation of the regenerating mangrove was observed. As the site is rapidly accreting, this site will continue to grow, and its importance as a site for migratory waterbirds may increase.

We recommend the following action to maintain and increase the biodiversity importance of this site:

- Establishment of the site as a decreed nature reserve;
- Designation of the site as a wetland of international importance under the Ramsar Convention, preferably in a site combining Bai Boi and Dat Mui (see below). The two sites should also be nominated under the East Asian-Australasian Shorebird Network;
- Efforts to locate funds to improve the facilities for site staff should be made;
- No mangrove planting should be carried out in areas of accreting mudflats. This is an important habitat for migratory waterbirds and will become naturally re-colonised by mangrove at rates that are unlikely to compromise this importance;
- No further development of aquaculture should be permitted within the site boundary;
- Fishing activities should be strictly controlled to minimise the disturbance to migratory waterbirds; and
- Establishment of a monitoring programme to examine the importance of the site to migratory waterbirds (as would be required under the Ramsar Convention) including training of staff in monitoring techniques.

Criteria scores for Bai Boi.

Area. 5,525 ha. Score: 4

Diversity (species).
Shannon's Diversity Index: 1.656. Score: 1
Species richness: 52 species. Score: 3
Uniqueness: 3.774. Score: 3
Taxonomic relatedness: 3.523. Score: 0

Diversity (habitats). Six habitats recorded. Score: 3

Rarity (species). Chinese Egret (EN), Asian Dowitcher (NT), Eastern Curlew (NT) and Painted Stork (NT). Score: 6

Rarity (habitats). Undisturbed mudflats. Score: 1

Species congregation. Likely to support 1% of the world population of Chinese Egret. Score: 1

Naturalness. No natural or semi-natural habitats. Score: 0

Fragility. No fragile habitats. Score: 0

Special role in maintaining biological diversity. No bird species were confined to this site. Score: 0

Position as an ecological unit. Contiguous with Dat Mui, forming an extensive area of coastal mangroves and mudflats. Score: 1

Conservation management potential. As there is little unsustainable usage of the site, it is possible that conservation inputs could have a beneficial impact here. Score: 2

Potential education and cultural value. Attracts visitors who come to see the southernmost part of mainland Vietnam. Score: 1

Conservation momentum. Already classed as coastal Protection Forest, but has attracted support from provincial authorities in becoming a nature reserve. Score: 1

Conservation value. Already classed as coastal Protection Forest. Score: 1

Total Score: 28
Ranking: 6

6.3 Dat Mui Nature Reserve

General description. Dat Mui (8°34'-8°41'N 104°41'-104°48'E; Map 3) includes the southernmost tip of Vietnam. The site was originally natural mangrove forest, but the vast majority was destroyed during the American War and subsequently to make way for shrimp ponds and agricultural land. Most of these have now been abandoned, and they form extensive areas with patches of re-colonising mangrove. There are extensive mudflats, which are also being colonised by naturally regenerating mangrove. This site is contiguous with Bai Boi, and together they comprise an important area of intertidal mudflats and mangrove for migratory waterbirds. The site is growing every year due to accretion rates along the coastline of up to 50 m per year in places.

Status. Dat Mui is a decreed nature reserve. The decree indicates a site area of 4,000 ha, though the site managed by the FPD covers 7,239 ha. Of this area, 4,388 ha are described as Special-use Forest by the site staff. However, they only treat 1,717 ha of this as 'strictly protected'. The management authority is the provincial FPD.

Flora. The coastal mangrove here was quite similar to that on the islands at Bai Boi, with *Avicennia* spp. (*A. alba*, *A. officinalis*, and *A. marina*) dominating, and *Rhizophora apiculata*, *Kandelia candel*, some *Bruguiera* sp. and *Sonneratia* sp. occurring sporadically.

Some small areas of old natural *Rhizophora* mangrove were found at Dat Mui. This vegetation type probably covered much of the area in the past. Evidence of over-exploitation was frequent, with many old logged bases of large *Rhizophora apiculata* trees present. There were still some big trees (over 10 years old) of 8-10 m height and >20 cm DBH, though generally the habitat was degraded. Young *R. apiculata* trees were also regenerating here. Mixed with this species were *Avicennia* spp., *Kandelia candel*, *Bruguiera* sp., *Sonneratia* sp., and *Xylocapus granatum*. On the muddy banks, *Thespesia populnea*, *Acrostichum aureum*, *Derris trifolia*, *Wedelia biflora*, *Pluchea indica*, *Sesuvium portulacastrum*, *Cyperus* spp. and *Fimbristylis* spp. were found.

Rhizophora apiculata plantations of different ages were extensive at Dat Mui. The planting density varied greatly, from 1 to 6 trees m^{-2}.

Birds. As with Bai Boi, this site appeared to be an important site for a number of migratory shorebirds,

egrets, gulls and terns. In March, nine Chinese Egrets and eight species of shorebird were recorded including the globally near-threatened Eastern Curlew (two) and Grey-headed Lapwing (one). Large concentrations of Caspian (max: 209) and Whiskered Terns (355) were recorded: the count of Caspian Tern constitutes up to 2.1% of the east and South-East Asian population of the subspecies *caspia*.

In August, migratory shorebirds were much more numerous, particularly on the complex of disused agricultural land with exposed mud and remnant and regenerating mangrove, which constitutes a large proportion of the site. Eighteen species of shorebird were recorded, including over 140 Asian Dowitchers (Table 9). If accessibility and site turnover are taken into account, this site is likely to support more than 1% (180) of the global population of this globally near-threatened species.

Also of note were 322 Eurasian Curlew *Numenius arquata*, which constitutes up to 3.2% of the East and South-East Asian population of the subspecies *orientalis*. Also of importance were substantial numbers of Painted Stork and Black-headed Ibis, though neither species appeared to be breeding, and one Spot-billed Pelican. A single Eastern Curlew was also recorded.

Threats and conservation recommendations. The mangrove forests of Dat Mui have been severely degraded in the last 10 years, largely as a result of illegal encroachment and conversion to aquacultural ponds. Considerable effort has been made to restore the site and many illegal settlers have been evicted. However, there are substantial numbers of people living in or around the site and encroachment into even the strictly protected area occurs frequently. Mangrove is still exploited where it remains, and all the mature mangrove at the site appears to be severely degraded.

We recommend the following action:

- There is a need for more effective protection of the 'strictly protected' area, which should include clear marking of the boundary. Currently, access to the strictly protected area is easy along the numerous canals and river channels throughout the site. A system of gates or canals is required to allow effective protection of this area;

- The confusion regarding the extent of the nature reserve also needs to be addressed, and a boundary marked so that local people are aware of its presence and site staff can manage it accordingly;

- The site should be designated as a wetland of international importance under the Ramsar Convention, preferably in a site combining Dat Mui and Bai Boi (see above);

- Efforts to locate funds to improve the facilities for site staff should be made;

- No mangrove planting should be carried out in areas of accreting mudflats. This is important habitat for migratory waterbirds and will become naturally re-colonised by mangrove at rates that are unlikely to compromise this importance. The disused agricultural land also provides important habitat for migratory waterbirds and no re-planting should take place here;

- No further development of aquaculture should be permitted within the site boundary;

- Human activities should be strictly controlled to minimise the disturbance to migratory waterbirds; and

- A monitoring programme should be established to examine the importance of the site to migratory waterbirds (as would be required under the Ramsar Convention) including training of staff in monitoring techniques. The areas of disused agricultural land should be monitored to establish whether natural mangrove regeneration here would lead to a decline in the utilisation of the site by migratory waterbirds.

Criteria scores for Dat Mui.

Area. 7,239 ha. Score: 4

Diversity (species).
Shannon's Diversity Index: 2.234. Score: 2
Species richness: 65 species. Score: 4
Uniqueness: 3.398. Score: 3
Taxonomic relatedness: 3.29. Score: 0

Diversity (habitats). Four habitats recorded. Score: 2

Rarity (species). Chinese Egret (EN), Spot-billed Pelican (VU), Black-headed Ibis (NT), Painted Stork (NT), Asian Dowitcher (NT), Eastern Curlew (NT), Grey-headed Lapwing (NT). Score: 10

Rarity (habitats). Undisturbed mudflats. Score: 1

Species congregation. Likely to support 1% of the global population of Chinese Egret and Asian Dowitcher. Score: 2

Naturalness. Some mature semi-natural mangrove, but highly degraded. Score: 0

Fragility. No fragile habitats. Score: 0

Special role in maintaining biological diversity. Two resident species were confined to this site: Laced Woodpecker *Picus vittatus* and Slaty-breasted Rail *Gallirallus striatus*. Score: 2

Position as an ecological unit. Contiguous with Bai Boi. Score: 1

Conservation management potential. Unsustainable use is probably widespread, but high human population pressure around the site would restrict the speed and efficacy of action to transform the situation. Score: 1

Potential education and cultural value. Cultural significance as it includes the southernmost tip of mainland Vietnam, and attracts tourists as a result. Score: 1

Conservation momentum. The site has attracted government support for conservation, and even though part of the area is already protected it is possible that additional areas could be given nature reserve status. Score: 1

Conservation value. Part of the site is already decreed a nature reserve. Score: 1

Total Score: 35
Ranking: 4

6.4 Vo Doi Nature Reserve, Tran Van Thoi and U Minh III

General description. Vo Doi Nature Reserve, Tran Van Thoi and U Minh III (9°11'-9°18'N 104°52'-104°59'E; Map 4) are areas of *Melaleuca* forest and seasonally inundated grassland in the U Minh peatswamps of Ca Mau province. The site lies c. 40 km north-west of Ca Mau town. Vo Doi itself covers 3,724 ha but is bounded to the north by two other large forestry concessions, U Minh III and Tran Van Thoi. These together comprise U Minh Ha, or 'lower' U Minh, the southern of the two extensive peatswamp areas in Kien Giang and Ca Mau provinces. Together the three areas constitute some 10,991 ha. The provincial government are proposing to extend Vo Doi Nature Reserve to include U Minh III and Tran Van Thoi, which are no longer commercially exploited. This will enhance the site considerably, as the extension includes extensive areas of mature *Melaleuca* plantation and seasonally inundated grassland and swamp.

Within the site, pH measurements of 6.1 to 6.3 indicated no acidification problem, but in the main canal outside the site, pH was only 3.1, suggesting that the nature reserve has considerable beneficial effects on water quality in the area.

Status. Vo Doi is a decreed nature reserve covering 2,000 ha, managed by the provincial FPD. However, the whole site covers some 3,724 ha, and there is no distinction on the ground between the nature reserve area and the rest of the site. Nevertheless, the whole site is effectively given full protection by nature reserve staff. The proposed extension areas of Tran Van Thoi and U Minh III are still officially Production Forest, though are not commercially exploited to any great extent.

Flora. Three major vegetation types were found at Vo Doi: semi-natural *Melaleuca* forest, *Melaleuca* plantation and seasonally inundated grassland.

Semi-natural *Melaleuca* forest consisted of two clear strata. The tree layer comprised *Melaleuca* at a density of 1-2 trees m^{-2}, with other tree species found in small numbers, including *Ilex cymosa*, and *Alstonia spathulata*. The climbing plant flora here was well developed, including *Stenochlaena palustris*, *Flagellaria indica*, *Scleria sumatrensis* and sometimes *Dioscorea glabra*. On the banks along the forest edge, dense stands of *Stenochlaena* and *Scleria sumatrensis* were found along with *Cayratia trifolia*, *Ageratum conyzoides*, *Thespis divaricata*, *Vigna luteola* and *Hygrophila salicifolia*.

Melaleuca plantations of varying ages cover a large area in the eastern half of the site. Many of the stands are mature, and relatively open, so the ground layer has developed well. There are also areas of grassland with young naturally regenerating *Melaleuca*.

The commonest grassland community was dominated by *Eleocharis dulcis*. Also present were *Cyperus halpan*, *C. polystachyos*, *Fuirena umbellata*, *Philydrum lanuginosum* and *Phragmites vallatoria*. Patches of *Cyperus elatus* and *C. digitatus* were occasionally found in *Phragmites* and *Eleocharis* grassland. On slightly higher ground, the *Phragmites vallatoria*-dominated community was found, including other common species such as *Cayratia trifolia*, *Vigna luteola*, *Panicum repens*, *Leersia hexandra*, *Saccharum spontaneum*, *Flagellaria indica*, *Lygodium scandens* and *Melastoma affine*. *Phragmites* sometimes formed a thick wall reaching 3 m in height.

The canals in areas of *Melaleuca* forest supported a diverse community of floating, aquatic and subaquatic species, including *Eichhornia crassipes*, *Pistia stratiotes*, *Salvinia cucullata*, *Ipomoea aquatica*, *Ludwidgia adscendens*, *Centrostachys aquatica*, *Azolla pinnata*, *Spirodela polyrrhiza*, *Lemna aequinoxialis* and the rare duckweed species *L. tenera* (Tran Triet, verbally).

Birds. Vo Doi and the surrounding areas of Tran Van Thoi and U Minh III supported a high bird species richness, with 82 species recorded over the two visits, the third highest total of any site visited. In particular the site supported a high abundance and species richness of waterbirds, including small bitterns (*Ixobrychus*, *Dupetor*), Bronze-winged Jacanas and Purple Swamphens *Porphyrio porphyrio*. However, no globally threatened or near-threatened species were recorded. There are records of adjutants, probably Lesser Adjutant, in recent years, and they were believed to breed at the site in the past, but appear to no longer do so in Vo Doi. They may however, still occur in the extension area of U Minh III and Tran Van Thoi. Local staff also reported frequent sightings of Woolly-necked Stork *Ciconia episcopus* in the extension area, where it might breed. The reasons for the apparent absence of the larger waterbirds is not clear, but may be due to disturbance and habitat deterioration in the past, partly due to forest fires (see below).

The mature forest supported a relatively high species richness of woodland birds, including Scarlet Minivet and Indochinese Cuckoo-shrike.

Other fauna. Sambar has been reported from the site, and two captive individuals were held in a compound in the centre of Vo Doi Nature Reserve during the survey period, apparently to be released at a later date. Whether this species still occurs in a wild state is unclear, though during the August visit nature reserve staff found a shed antler. The same guard station also had a large *Python* sp. in captivity, which had reportedly been captured within the site. Unidentified squirrels *Callosciurus* sp. were frequently seen amongst canal-side bamboo palms.

A large colony of fruit bats *Pteropus* sp. was known to occur at Vo Doi in the past, but according to local staff no longer does so. However, in August a single *Pteropus* bat was seen flying over the site at dusk. It is conceivable that the colony has relocated to the extension area or still exists in a reduced state somewhere in Vo Doi.

Threats and conservation recommendations. The site is relatively well protected, and local people are aware of its status as a nature reserve. According to nature reserve staff, the main threat appears to be accidental forest fires. In 1995, a fire destroyed some 200 ha of *Melaleuca* forest. The 1999 dry season was unusually wet and staff reported that this had significantly reduced the risk of fire. A number of watchtowers are used for advanced warning of fires. Honey is harvested throughout the site and the use of smoke in collecting honey from beehives may be a contributory factor to forest fires. Reserve staff also reported patches of *Melaleuca* die-off, though the reasons for this were not clear.

We recommend the following conservation action:

- The extension of Vo Doi to include the surrounding areas of U Minh III and Tran Van Thoi is an important step to establishing this as a protected area of high importance. The levels of protection afforded to Vo Doi should be repeated in the extension area, which will require additional staff and facilities. It is important that the levels of encroachment into the extension area are reduced if the site is to recognise its full potential;

- Honey-harvesting is a potentially sustainable use of *Melaleuca* forest that should be encouraged, but needs to be carefully controlled to minimise the risk of fires. In particular, collection by smoking of beehives should be strictly prohibited during the dry season;

- Vo Doi, together with the extension area, should be designated as a wetland of international importance under the Ramsar Convention, as it contains a representative and rare example of a near-natural wetland type found within the biogeographic region (peatswamp *Melaleuca* forest).

Criteria scores for Vo Doi Nature Reserve, Tran Van Thoi and U Minh III.

Area. 10,991 ha (including extension). Score: 5

Diversity (species).
Shannon's Diversity Index: 2.182. Score: 2
Species richness: 82 species. Score: 5
Uniqueness: 5.501. Score: 1
Taxonomic relatedness: 3.656. Score: 1

Diversity (habitats). Four habitats recorded. Score: 2

Rarity (species). No globally threatened or near-threatened species recorded. Score: 0

Rarity (habitats). Semi-natural mature *Melaleuca* forest and seasonally inundated grassland. Score: 2

Species congregation. No major concentrations of birds. Score: 0

Naturalness. Semi-natural mature *Melaleuca* forest and seasonally inundated grassland. Score: 2

Fragility. Seasonally inundated grassland. Score: 1

Special role in maintaining biological diversity. Four resident bird species confined to the site: Black Kite *Milvus migrans*, Ashy Drongo *Dicrurus leucophaeus*, Puff-throated Babbler *Pellorneum ruficeps* and Large-billed Crow *Corvus macrorhynchos*. Score: 4

Position as an ecological unit. The site is part of the larger U Minh Ha wetland ecosystem. Score: 1

Conservation management potential. Although unsustainable usage of Vo Doi is low, the proposed extension will incorporate additional areas into the site, from which forest products are currently obtained in an unsustainable manner. Score: 2

Potential education and cultural value. No visitor facilities currently exist. Score: 0

Conservation momentum. The proposed extension area constitutes an important addition to the site, and indicates government support for its conservation. Score: 1

Conservation value. Vo Doi has nature reserve status. Score: 1

Total Score: 30
Ranking: 5

6.5 Tra Su

General description. Tra Su (10°33'-10°36'N 105°02'-105°04'E; Map 5) is a small (860 ha), square block of *Melaleuca* plantation and seasonally inundated grassland and swamp in An Giang province. Additional areas of *Melaleuca* forest bordered the site on two sides in the past, but this has all now been cleared and converted to rice cultivation, so that the site is now surrounded by paddyfields. The site is divided in two by a main canal, with the western half being mature *Melaleuca* plantation with patches

of open swamp, much of which has now been planted with *Melaleuca* saplings. The eastern half of the site consists of dense, young *Melaleuca* plantation, one area of which holds a large colony of breeding waterbirds, and an area of seasonally inundated grassland.

Measurements of pH in paddyfields adjacent to the site indicated severe acidity problems here, with readings as low as 2.9. Within the site however, pH was 6.3, highlighting the beneficial effect of maintaining this site as a semi-natural wetland.

Status. Tra Su is commercial Production Forest, managed by the provincial FPD. However, part of the site is managed as a bird sanctuary, though it is not decreed as such.

Flora. Vegetation types here were similar to those at Tinh Doi (see below). Mature *Melaleuca* plantation had a mean tree density of 2 trees m^{-2}, a mean height of 8 m and mean DBH of 11 cm. Estimated canopy coverage was 67%. Young *Melaleuca* plantation was dense, comprising around 8 trees m^{-2}, with a mean height of 5 m, mean DBH of 4 cm, and an estimated canopy coverage of 90%.

Open grassland communities comprised mainly *Eleocharis dulcis* meadow in swampy areas with *Nymphoides indica*, *Ludwidgia adscendens*, *Ipomoea aquatica* and *Cyperus iria* also found in this community. *Hymenachne acutigluma* meadow occurred in swampy areas with *Sesbania cannabina* scrub and floating vegetation including *Nymphoides indica* and *Ludwidgia adscendens*. *Panicum repens* meadow together with scattered *Phragmites vallatoria* occurred in drier areas. Some of the grassland areas have been invaded by the exotic *Mimosa pigra*, a native of tropical America, which has become a serious pest in other areas where it has been inadvertently introduced.

Birds. Despite its small size, Tra Su has some interesting and important components to its avifauna. Three globally near-threatened species were recorded here, Painted Stork (flying over in January), Oriental Darter (breeding in very small numbers) and Asian Golden Weaver (several small colonies in shrubs on edge of grassland). Also of note was the sizeable colony of breeding waterbirds, including over 300 Purple Herons, Black-crowned Night Herons *Nycticorax nycticorax* and Little Cormorants. The maximum count of Purple Heron (319) constitutes up to 3.2% of the South-East Asian population of the subspecies *manilensis* (see Table 8). Small numbers of Indian Cormorant were present in August.

The *Melaleuca* plantation is mature in places but supports a low species richness of woodland birds. However, the area seems to be an important roost site for other non-wetland species such as Red Collared Dove *Streptopelia tranquebarica* (several hundred recorded) and Chestnut-tailed Starling *Sturnus malabaricus*.

Threats and conservation recommendations. The main threats to the biodiversity value of this site come from:

- Continued planting of *Melaleuca* saplings in areas of open swamp; and
- The small size and highly fragmented nature of the habitat type in this area of An Giang province.

The bird colony is currently given protection by local staff, but any commercial exploitation of the *Melaleuca* in the vicinity is likely to cause the colony to disperse. The site holds a significant population of Asian Golden Weaver, but the fragmented nature of this site means that this population may not be viable in the long term. Another threat to this species here appears to be the gradual encroachment of *Melaleuca* and *Mimosa pigra* scrub. Streaked Weaver *Ploceus manyar,* which also occurs at this site,

prefers more scrubby areas, and aggressive interactions between the two species around nest site trees were frequently seen. The two species often had small colonies in adjacent bushes.

We recommend the following conservation action:

- Notification of the eastern half of the site as a nature reserve under provincial legislation;
- Cessation of *Melaleuca* planting in areas of open swamp and grassland;
- Implementation of control measures for *Mimosa pigra;*
- Continued strict protection of the important waterbird colony in the eastern half of the site; and
- Establishment of a finance scheme whereby profits from harvested *Melaleuca* in the western half of the site are used to support the activities necessary to conserve the biodiversity in the eastern half.

Criteria scores for Tra Su.

Area. 860 ha. Score: 3

Diversity (species).
Shannon's Diversity Index: 1.817. Score: 1
Species richness: 67 species. Score: 4
Uniqueness: 5.383. Score: 1
Taxonomic relatedness: 3.767. Score: 1

Diversity (habitats). Four habitats recorded. Score: 2

Rarity (species). Painted Stork, Oriental Darter and Asian Golden Weaver (all NT). Score: 3

Rarity (habitats). Seasonally inundated grassland. Score: 1

Species congregation. No species represented by 1% or more of its population. Score: 0

Naturalness. Seasonally inundated grassland. Score: 1

Fragility. Seasonally inundated grassland. Score: 1

Special role in maintaining biological diversity. One resident bird species confined to the site: Barn Owl *Tyto alba*. Score: 1

Position as an ecological unit. An isolated site surrounded by rice cultivation. Score: 0

Conservation management potential. Although *Melaleuca* is still harvested at this site it is carried out in a sustainable manner. Score: 1

Potential education and cultural value. None. Score: 0

Conservation momentum. This site is a commercial Production Forest, yet so far the site managers have protected the bird colony and are interested in conserving the remaining areas of seasonally inundated grassland. Score: 1

Conservation value. Restricted land use due to forestry operations. Score: 1

Total Score: 22
Ranking: 8

6.6 Tinh Doi

General description. Tinh Doi (10°18'-10°23'N 105°02'-105°05'E; Map 6) is an area of *Melaleuca* plantation, with sizeable patches (totalling c. 380 ha) of seasonally inundated grassland. The site covers 1,643 ha. Much of the grassland has patches of *Melaleuca* scrub and young plantation within it. Some areas are inundated for much of the year to a depth making it unsuitable for *Melaleuca* growth. A canal, constructed between the two field visits, unfortunately bisected the largest section of grassland. The pH within this area of grassland was measured at 8.8, compared to only 2.8 in an adjacent canal, suggesting that further canal construction is likely to lead to decline in water quality.

Status. This site is commercial Production Forest, the management authority is the army.

Flora. The major vegetation type of this site was *Melaleuca* plantation. The oldest *Melaleuca* plantations consisted of 1 tree m^{-2}, with a mean height of 10 m, and a mean DBH of 12 cm. Estimated canopy coverage was 80%. Medium-age *Melaleuca* plantations were denser, with 3 trees m^{-2}, a mean height of 6 m and a mean DBH of 4 cm. Estimated canopy coverage was 75%. Young plantations of 8 trees m^{-2} had a mean height of 1.5 m. The ground flora was often sparse but included grasses such as *Eleocharis dulcis* and species from the Poaceae.

Areas of seasonally inundated grassland were dominated by *Eleocharis dulcis* with scattered *Melaleuca* saplings, *Panicum repens*, *Aniseia martinicensis* and *Paspalum paspalodes*.

Birds. The areas of grassland have good populations of common waterbirds such as Purple Swamphen and Little Cormorant. Of particular interest were two species that are scarce and seriously declining in South-East Asia: a group of five Comb Duck *Sarkidiornis melanotos*, and two Woolly-necked Storks. The former was not recorded at any other site during the project. The near-threatened Oriental Darter was also recorded here but only two individuals were seen and it is not known if it breeds at the site.

The *Melaleuca* plantation supports a low species richness of common woodland birds, such as Golden-bellied Gerygone, Pied Fantail and Olive-backed Sunbird.

Threats and conservation recommendations. The main threats to this site are:

- Continued planting of *Melaleuca* saplings in areas of open swamp;
- Channelisation, which will further fragment the remaining areas of seasonally inundated grassland as well as lead to declining water quality through oxidation of the acid-sulphate soils in the area; and
- Hunting of waterbirds.

Site staff were interested in maintaining some areas as 'protected areas' but these were only where inundation depths were too great to allow *Melaleuca* planting, and most consisted of degraded *Eleocharis dulcis* grassland. Furthermore, there was evidence of hunting of waterbirds within the area that had been identified as potentially for protection (lines of fishing hooks suspended along canal banks, usually aimed at catching medium-sized waterbirds). The canal mentioned above bisected the main area of wet grassland and there are plans to plant it with *Melaleuca*. As a result the main biodiversity value of this area is likely to be lost.

We recommend the following conservation action:

- Cessation of *Melaleuca* planting in areas of grassland and open swamp;
- No further channelisation within areas of grassland and open swamp; and
- Establishment of a strictly protected area where disturbance is minimised and no hunting is permitted.

Criteria scores for Tinh Doi.

Area. 2,053 ha. Score: 4

Diversity (species).
Shannon's Diversity Index: 2.102. Score: 2
Species richness: 68 species. Score: 4
Uniqueness: 5.357. Score: 1
Taxonomic relatedness: 3.601. Score: 1

Diversity (habitats). Four habitats recorded. Score: 2

Rarity (species). Oriental Darter (NT). Score: 1

Rarity (habitats). Seasonally inundated grassland. Score: 1

Species congregation. None. Score: 0

Naturalness. Seasonally inundated grassland. Score: 1

Fragility. Seasonally inundated grassland. Score: 1

Special role in maintaining biological diversity. One resident (Comb Duck) and two winter visiting bird species (Garganey *Anas querquedula*, Japanese Sparrowhawk *Accipiter gularis*) were confined to the site. Score: 3

Position as an ecological unit. An isolated site, surrounded by rice cultivation. Score: 0

Conservation management potential. Although *Melaleuca* is still harvested at this site it is carried out in a sustainable manner. Score: 1

Potential education and cultural value. None. Score: 0

Conservation momentum. There is interest on the part of provincial authorities to establish a nature reserve at the site. Score: 1

Conservation value. The site has restricted access due to forestry activity. Score: 1

Total Score: 24
Ranking: 7

6.7 Ha Tien plain

General description. The Ha Tien plain is the last remaining extensive area of seasonally inundated grassland in the Mekong Delta. Two areas of grassland were visited, and are treated here together, as they constitute part of the wider Ha Tien plain. An area of c. 6,981 ha north-west of Ha Tien town (10°20'-10°29'N 104°32'-104°39'E; Map 7a) consisted of a mixture of grassland and naturally regenerating *Melaleuca* scrub on acid sulphate soil and old alluvial sediments. This area is still relatively intact. A second block of 7,624 ha in Kien Luong district (10°09'-10°17'N 104°34'-104°42'E; Map 7b) consisted of grassland with some brackish water characteristics, on acid-sulphate soil. The area is fragmented by a series of new canals, but still holds significant populations of threatened wetland birds. Measurements of pH in the Kien Luong area suggest that the area has already been affected by acidification, with readings as low as pH 3.4.

Status. This area has no official status. Most of it is earmarked for resettlement.

Flora. The Ha Tien site comprised a mixture of grassland, *Melaleuca* scrub and *Nypa fruticans* swamp, and has been described in Tran Triet *et al*. (in press), from which much of the following description is taken.

Grasslands were dominated by a species-poor *Eleocharis dulcis* community, which formed the most extensive area. *E. dulcis* was sometimes the only species occurring, although *Cyperus halpan*, *C. polystachyos*, *Philydrum lanuginosum* and *Murdannia giganteum* also occurred frequently. A *Lepironia articulata* community also occurred locally with other species such as *Eleocharis ochrostachys*, *E. dulcis*, *Scleria poaeformis* and *Ischaemum rugosum*. Species-rich *Eragrostis atrovirens* and *Setaria viridis* communities were found in association with *Eragrostis tremula*, *E. malayana*, *Setaria pallide-fusca*, *Panicum repens*, *Hemarthria longiflora*, *Mnesithea laevis*, *Paspalum commersonii*, *P. longifolium*, *Rhynchospora rubra*, and *Desmodium triflorum*. A species-rich *Mnesithea laevis* and *Ischaemum rugosum* community was also found. A community dominated by *Zoysia matrella* was locally distributed in the area along the coast. Associated species were *Cyperus arenarius*, *C. bulbosus*, *Scirpus juncoides*, *Xyris pauciflora* and *Paspalum vaginatum*.

Melaleuca scrub consisted of trees from 2 to 6 m tall, but locally reaching 10-12 m, with a DBH of 10-20 cm. The composition of the ground flora varied depending on the soil and water conditions but often included *Eleocharis dulcis*, *Phragmites vallatoria*, *Xyris indica*, *Melastoma affine*, *Flagellaria indica*. In some areas *Paspalum vaginatum*, *Pandanus kaida* and the fern *Acrostichum aureum* were found along with *Eleocharis dulcis*.

In the brackish water zone, the aquatic palm *Nypa fruticans* dominated, reaching up to 8 m in height. Associated species included *Acanthus ebracteatus*, *Derris trifolia*, *Clerodendrum inerme*, *Phoenix paludosa*, *Acrostichum aureum*, *Aglaodora griffithii* and *Cyperus malaccensis*.

At the Kien Luong site, the vegetation was dominated by *Eleocharis ochrostachys*. Patches of other species

such as *E. dulcis*, *E. retroflexa, Xyris indica*, *Scleria poaeformis*, *Melastoma affine*, *Scirpus grossus*, *Fimbristylis* sp., *Pseudoraphis brunoniana*, *Cyperus* spp., and *Lepironia articulata* were also found.

Birds. This area provided some of the most important findings of the project. Of high conservation interest was a flock of at least 135 Sarus Crane of the eastern subspecies *sharpii*. The total population of this subspecies is thought to be only 500-1,500 individuals, with the majority spending the dry season at Tram Chim National Park, the only known regular dry season site for this subspecies in Vietnam. This site may therefore support up to a quarter of the global population of this subspecies.

Another indication of the importance of this area came from two sightings of the globally endangered White-shouldered Ibis, a single bird in April and a pair feeding together in August. The presence of this species during both survey periods may indicate that a small breeding population exists in the vicinity. These sightings constitute two of only a handful of recent records anywhere of this species, which has drastically declined over its entire range (Collar *et al.* 1994). The only recent sightings in Vietnam have come from Cat Tien National Park in Dong Nai province.

Other large waterbirds recorded included the globally vulnerable Spot-billed Pelican (one), the globally near-threatened Painted Stork (one) and a group of eight Woolly-necked Storks, a species that has declined throughout much of Asia (Lekagul and Round 1991; Thewlis *et al.* 1998).

Remains of a single Bengal Florican (globally endangered) were found in the vicinity in 1997 (Tran Triet *et al.* in press). As water levels were unseasonably high during the survey visits it was not feasible to search for this species but local people were familiar with it and it is likely that it still exists here. The only other currently known location for this species in Vietnam is Tram Chim National Park in Dong Thap province (see below). The population at Tram Chim however, is very small and if significant numbers still exist in the Ha Tien plain this may be the only viable population of the species remaining in Vietnam.

A number of other grassland specialists were recorded during the surveys, including Chinese Francolin *Francolinus pintadeanus* and Rufous-winged Bushlark *Mirafra assamica*, the only sites where these species were recorded.

Threats and conservation recommendations. The Ha Tien plain currently has no protected areas, and is under severe threat from conversion of seasonally inundated grassland to rice agriculture and forestry. Most of the large areas remaining are currently earmarked for resettlement and agricultural conversion. However, the acid-sulphate soils in the area make most of the plain unsuitable for rice agriculture. There is a real risk, therefore, that the last remaining areas of extensive seasonally inundated grassland in the Mekong Delta will be lost to provide marginal agricultural land capable of producing meagre rice crops of less than 1 tonne ha^{-1} yr^{-1}.

The Kien Luong site is further threatened by plans for a major flood control canal that will bisect the site, leading to further fragmentation, changes in flooding regimes and subsequent deterioration of soil fertility through acidification. The construction of this canal is also likely to have serious impacts on the globally threatened large waterbirds found at the site by increasing levels of disturbance.

We recommend the following conservation action:

- The immediate cessation of *Melaleuca* planting and human resettlement in the areas surveyed, until measures can be taken to conserve these sites;

- The establishment of two protected areas should be regarded as a high priority, incorporating grasslands in the Kien Luong site and the Ha Tien site described above;

- The promotion of sustainable use of other remaining areas of grassland in the Ha Tien plain, for example through cultivation of *Melaleuca* forest rather than rice;

- Mitigation of the adverse impacts of the flood control canal at Kien Luong, through establishment of a protected area and efforts to minimise the impact the canal construction will have on flooding regimes and disturbance levels; and

- Suspension of the *Eucalyptus* planting currently being carried out by a Taiwanese company on grassland of the Ha Tien Plain, which has had a devastating effect on water quality.

Criteria scores for the Ha Tien plain.

Area. Two areas, constituting c. 16,000 ha. Score: 5

Diversity (species).
Shannon's Diversity Index: 1.758. Score: 1
Species richness: 79 species. Score: 4
Uniqueness: 4.940. Score: 2
Taxonomic relatedness: 3.679. Score: 1

Diversity (habitats). Seven habitats recorded. Score: 4

Rarity (species). White-shouldered Ibis (EN), Spot-billed Pelican (VU), Sarus Crane (NT), Painted Stork (NT). Score: 7

Rarity (habitats). Large expanse of seasonally inundated grassland. Score: 1

Species congregation. 5% of the population of eastern Sarus Crane. Score: 5

Naturalness. Seasonally inundated grassland. Score: 1

Fragility. Seasonally inundated grassland. Score: 1

Special role in maintaining biological diversity. Three resident (White-shouldered Ibis, Chinese Francolin, Rufous-winged Bushlark) and one winter visiting bird species (Common Stonechat *Saxicola torquata*) confined to the site. Score: 4

Position as an ecological unit. Forms part of the Ha Tien plain. Score: 1

Conservation management potential. Unsustainable exploitation of seasonally inundated grasslands in the Ha Tien plain is widespread but provincial government support has been forthcoming regarding the possibility of establishing one or two new protected areas, and the situation may therefore be transformed effectively. Score: 3

Potential education and cultural value. The nearby Hon Chong Cultural and Historical Site suggests that promoting eco-tourism in the area may be possible. Score: 1

Conservation momentum. Not yet part of a protected area, but interest from provincial government in establishing new protected areas has been forthcoming. Score: 1

Conservation value. No protected areas or areas of limited access currently exist here. Score: 0

Total Score: 42
Ranking: 1

6.8 U Minh Thuong Nature Reserve

General description. U Minh Thuong Nature Reserve (9°29'-9°42'N 105°01'-105°09'E; Map 8) is the largest site visited during the surveys, consisting of some 22,918 ha. The core zone (8,468 ha) consists of mature semi-natural *Melaleuca* forest, seasonally inundated grassland and open swamp. The remainder is classed as a buffer zone, most of which consists of paddyfields with small patches of *Melaleuca* plantation. A large block of *Melaleuca* plantation in the north-western corner of the site holds an important breeding colony of wetland birds, but is not officially part of the site. However, it is managed by a local prison and is treated as part of the reserve by local people. As with Vo Doi Nature Reserve, this site appears to have a beneficial effect on water quality, with pH measurements of 7.1 to 9.0 within the site.

Status. U Minh Thuong was decreed as a nature reserve in 1993, and is managed by MARD. However, the decreed nature reserve area is only 8,504 ha. On site, the boundary is given as including over 13,000 ha of buffer zone. This buffer zone is not officially managed by the FPD, and is therefore not under strict protection.

Flora. The vegetation communities at this site were similar to those at Vo Doi. The forest was dominated by *Melaleuca* but other tree species were frequent: *Trema orientalis* and *Combretum acuminatum* were confined to forest edge. The ground flora comprised abundant ferns such as *Stenochlaena palustris*, *Asplenium* sp., *Cyclosorus* sp. and *Acrostichum aureum* together with *Flagellaria indica* and *Scleria sumatrensis*. *Nepenthes mirabilis* was recorded, but was scarce. The ground flora also included patches dominated by *Phragmites vallatoria* or *Eleocharis dulcis*.

Canals through *Melaleuca* forest supported a diverse community of floating, aquatic and subaquatic species including *Eichhornia crassipes*, *Pistia stratiotes*, *Salvinia cucullata*, *Ipomoea aquatica*, *Ludwidgia adscendens*, *Centrostachys aquatica*, *Azolla pinnata*, *Spirodela polyrrhiza*, *Lemna aequinoxialis* and the rare duckweed species *L. tenera* (Tran Triet, pers. comm.).

Two main types of swamp grass and sedge communities were found in the open swamps. A community dominated by *Phragmites vallatoria* contained other common species such as *Vigna luteola*, *Cayratia trifolia*, *Panicum repens*, *Leersia hexandra*, *Saccharum spontaneum*, *Flagellaria indica*, *Lygodium scandens* and *Melastoma affine*. On higher ground, *Phragmites* formed a thick wall reaching 3 m in height.

A community dominated by *Eleocharis dulcis* together with *Cyperus halpan*, *C. polystachyos*, *Fuirena umbellata*, *Philydrum lanuginosum* and *Phragmites vallatoria* was also frequent. Patches of *Cyperus elatus* and *C. digitatus* were occasionally seen amongst *Phragmites* and *Eleocharis* grassland.

In other areas subject to more prolonged inundation, some different plant communities were found, including *Typha* swamp, characterised by *T. angustifolia*. *Nymphaea* swamp was dominated by *N. nouchali* in association with *Nymphoides indica*, *Ludwidgia adscendens*, *Utricularia aurea*, *Lemna aequinoxialis*,

Azolla pinnata, *Hydrilla verticillata* and *Ceratophyllum demersum*. *Eichhornia crassipes*, *Pistia stratiotes* and *Salvinia cucullata* formed mats amongst other vegetation types.

Birds. U Minh Thuong had the highest bird species richness of any of the sites visited, with 92 species recorded. This included a range of breeding waterbirds, several threatened or near-threatened species and several migrant species of wetland and non-wetland species. The high species richness probably reflects the diversity of habitats found, with mature forest, open swamp, dense *Phragmites vallatoria* grassland, and the surrounding buffer zone paddyfields (many of which are currently uncultivated) contributing to this richness.

The breeding colony in the north-western corner of the site is possibly the largest breeding colony of waterbirds in the delta. Over 5,000 individuals were recorded in May, and this is likely to be a considerable underestimate as it is currently only possible to observe birds flying into the colony from one direction. Of particular importance was a count of over 1,200 Glossy Ibis, which could represent as much as 8% of the South-East Asian population of this species. Other notable species included Asian Openbill (maximum of 73 individuals) and Black-headed Ibis (12), both of which are globally near-threatened.

The semi-natural *Melaleuca* forest of the core zone is the only currently known breeding site for Lesser Adjutant remaining in the delta. This population may be very small, as only two or three individuals have been regularly seen. However, the core zone is largely inaccessible due to the density of vegetation and as the species rarely leaves the forested area it is difficult to make an accurate assessment of the population size.

Many of the paddyfields of the buffer zone are currently uncultivated, and have been colonised by a variety of sedges and grasses. Some of these provide good foraging habitat for wetland birds, including Asian Openbill.

Threats and conservation recommendations. This site is undoubtedly one of the most important for biodiversity conservation in the delta. The core zone currently enjoys protection as a nature reserve, but the surrounding buffer zone is largely unprotected. During the survey period site staff began clearing canal bank vegetation in the centre of the core zone to provide land for planting of vegetable crops. The apparent aim of this was to establish a visitor facility in the core zone to demonstrate small-scale farming practices. This is unsuitable for the core zone of a nature reserve and would be better carried out in the buffer zone near the site headquarters.

Although the area of *Melaleuca* plantation holding the waterbird colony is effectively protected under management by the local prison, this part of the site should be incorporated into the nature reserve to ensure its long-term integrity.

As with Vo Doi, there is a risk from forest fires during the dry season, though watchtowers around the site allow for the early detection of fires, and the network of canals in the site provides firebreaks.

Criteria scores for U Minh Thuong Nature Reserve.

Area. 22,289 ha. Score: 5

Diversity (species).
Shannon's Diversity Index: 2.133. Score: 2
Species richness: 92 species. Score: 5
Uniqueness: 5.429. Score: 1
Taxonomic relatedness: 3.671. Score: 1

Diversity (habitats). Five habitats recorded. Score: 3

Rarity (species). Lesser Adjutant (VU), Black-headed Ibis (NT), Asian Openbill (NT). Score: 4

Rarity (habitats). Mature semi-natural *Melaleuca* forest and seasonally inundated grassland. Score: 2

Species congregation. Supports >5% of the South-East Asian population of Glossy Ibis, and >1% of the South-East Asian populations of Little Cormorant, Little Egret, Cattle Egret and Purple Heron. Score: 9

Naturalness. Mature semi-natural *Melaleuca* forest and seasonally inundated grassland. Score: 2

Fragility. Seasonally inundated grassland. Score: 1

Special role in maintaining biological diversity. Three resident (Lesser Adjutant, Asian Openbill, Grey-capped Pygmy Woodpecker *Dendrocopos canicapillus*) and one winter visitor (Yellow-breasted Bunting *Emberiza aureola*) were confined to the site. Score: 4

Position as an ecological unit. Surrounded by rice agriculture and not contiguous with the *Melaleuca* forests of U Minh Ha. Score: 0

Conservation management potential. The site is a protected area and levels of use are probably sustainable. Score: 0

Potential education and cultural value. No visitor facilities are available and access to the site is poor. Score: 0

Conservation momentum. Already has nature reserve status. Score: 0

Conservation value. Already has nature reserve status. Score: 1

Total Score: 40
Ranking: 3

6.9 Tram Chim National Park

General description. Tram Chim National Park (10°40'-10°47'N 105°26'-105°36'E; Map 9) constitutes the last remnants of the wetland ecosystem of the Plain of Reeds, which previously covered some 700,000 ha of Dong Thap, Long An and Tien Giang provinces. The site was given national park status in 1998.

The site comprises c. 7,740 ha including large areas of seasonally inundated grassland and *Melaleuca* forest. Large populations of waterbirds are found at the site, particularly in the winter when many thousands of waterfowl visit. Of particular importance is the population of Sarus Crane of the eastern subspecies *sharpii*, which spends the dry season in the park. Until recently this was the only known site in Vietnam where this species regularly occurred in large numbers. It is not yet clear whether the cranes spending the dry season in the Ha Tien area of Kien Giang province are part of the group which

normally occupies Tram Chim, but Tram Chim remains of prime importance for the conservation of this subspecies.

Status. Tram Chim was decreed as a 'Sarus Crane reserve' by Dong Thap province in 1986. In 1994 it was given nature reserve status at the national level, covering 7,500 ha. In 1998 a decree was issued establishing it as a national park. The area of the site described by site staff is 7,612 ha.

Flora. The flora of Tram Chim comprises a mixture of seasonally inundated grassland, regenerating *Melaleuca* forest and open swamp.

Tram Chim is one of the few places in the Plain of Reeds where the *Eleocharis* and wild rice *Oryza rufipogon* community is likely to survive to any extent. The dominant species were *Eleocharis dulcis* and wild rice with small patches of young *Melaleuca*. Associated species were *Cyperus halpan*, *Philydrum lanuginosum*, *Xyris indica* and *Phragmites vallatoria*. In the *Eleocharis ochrostachys*-dominated community, this species covered almost 100% of the ground surface, with *Eleocharis dulcis* (rare), *Pseudoraphis brunoniana*, *Eriocaulon setaceum*, *Blyxa aubertii* and *Eleocharis retroflexa*. Communities dominated by *Panicum repens*, *Ischaemum rugosum* or *Vossia cuspidata* were characterised by the above mentioned species with smaller coverage by *Eleocharis dulcis*, *E. retroflexa*, *Xyris indica*, *Lepironia articulata*, *Melastoma affine* and *Paspalum vaginatum*.

Melaleuca plantation, young forest and medium age forest were found in several areas. *Melaleuca* was present in some scattered patches, as clumps of stunted trees in areas of grassland or open swamp.

Lotus swamp was dominated by the lotus species *Nelumbo nucifera*, with *Nymphaea nouchali*, *N. pubescens*, and *N tetragona* also occurring. *Eleocharis dulcis*, *Ludwidgia adscendens*, *Centrostachys aquatica*, *Hymenachne acutigluma*, *Coix aquatica*, and *Leersia hexandra* also occurred.

Birds. Tram Chim National Park provides habitat for a wide diversity of wetland bird species, and had the second highest species richness of any site visited (88 species). This included several globally threatened or near-threatened species. The site is famous for the population of Sarus Crane that inhabits the site in the dry season. During the surveys, up to 203 cranes were observed but the regular counts carried out by site staff indicate that between 500 and 700 individuals spend the dry season here (Nguyen Van Hung, verbally). Other threatened wetland or wetland-dependent species recorded included Bengal Florican (globally endangered), of which a single male was seen in May. The status of this secretive grassland specialist at Tram Chim is not fully known, but it is likely that birds vacate the area during periods of substantial inundation in the late wet season. Local people believe the species breeds at the site, and claimed to have found both eggs and young of the species, though this could not be confirmed. Some people were also familiar with the characteristic display of the species.

Three other globally near-threatened species recorded during the surveys were Oriental Darter (up to five a day), Grey-headed Lapwing (one) and Asian Golden Weaver (one flock of c. 20). For the former, the site is probably of high importance, as site staff regularly record 80-90 individuals during organised counts (probably over 1% of the South-East Asian population though accurate figures are not currently available for this species).

Other species of conservation concern that have been recorded at the site are listed in Table 10.

Table 10: Globally threatened and near-threatened bird species which have been recorded at Tram Chim National Park, but were not recorded during our surveys. Threat categories are from Collar *et al.* (1994)

Species	Scientific name	Threat category	Status
Greater Spotted Eagle	*Aquila clanga*	Vulnerable	Rare winter visitor*
Black-headed Ibis	*Threskiornis melanocephalus*	Near threatened	Uncommon visitor*
Black-faced Spoonbill	*Platalea minor*	Critical	One confirmed record†
Painted Stork	*Mycteria leucocephala*	Near threatened	Fairly frequent visitor*
Asian Openbill	*Anastomus oscitans*	Near threatened	Uncommon visitor*
Greater Adjutant	*Leptoptilos dubius*	Endangered	Very rare visitor*
Lesser Adjutant	*Leptoptilos javanicus*	Vulnerable	Rare visitor*

*International Crane Foundation unpublished data.

†J.C. Eames, specimen record.

The richness of bird species found at Tram Chim is particularly noteworthy as most were wetland or wetland-dependent: the *Melaleuca* forest is not as mature as at U Minh Thuong and Vo Doi so true woodland species were scarce here. Other wetland species of note recorded during our surveys included Cotton Pygmy Goose *Nettapus coromandelianus*, Greater Painted-snipe *Rostratula benghalensis*, and several hundred Pheasant-tailed Jacana *Hydrophasianus chirurgus*.

Threats and conservation recommendations. Tram Chim now has national park status and therefore has a relatively high degree of protection, yet several threats remain. The frequent encroachment of people onto the reserve to hunt and collect firewood is the primary conservation issue. Second, because the site is surrounded by rice agriculture, land use activities around the site can have a substantial impact on the integrity of the wetland ecosystem of the national park. Examples of impacts are pollutant discharge and alteration of natural water levels.

Considerable effort has been made to improve the efficacy of protection at Tram Chim by the national park management board as well as the International Crane Foundation. We recommend that the management plan developed by these authorities be fully implemented. However, it is important that Tram Chim is not managed solely for the benefit of the Sarus Crane if this is to the detriment of other important and globally threatened species of bird and other organisms, as well as the integrity of the ecosystem as a whole.

Criteria scores for Tram Chim National Park.

Area. 7,740 ha. Score: 4

Diversity (species).

Shannon's Diversity Index: 1.975. Score: 1
Species richness: 88 species. Score: 5
Uniqueness: 5.554. Score: 1
Taxonomic relatedness: 3.697. Score: 1

Diversity (habitats). Four habitats recorded. Score: 2

Rarity (species). Bengal Florican (EN), Sarus Crane (NT), Grey-headed Lapwing (NT) Oriental Darter (NT), Asian Golden Weaver (NT). Score: 7

Rarity (habitats). Seasonally inundated grassland. Score: 1

Species congregation. More than 5% of the world population of eastern Sarus Crane. Score: 5

Naturalness. Seasonally inundated grassland. Score: 1

Fragility. Seasonally inundated grassland. Score: 1

Special role in maintaining biological diversity. Seven species confined to the site: Bengal Florican, Grass Owl *Tyto capensis*, Greater Painted-snipe, Intermediate Egret *Mesophoyx intermedia*, Shikra *Accipiter badius*, Pied Kingfisher *Ceryle rudis* and buttonquail *Turnix* sp. Score: 7

Position as an ecological unit. Now totally surrounded by rice cultivation. Score: 0

Conservation management potential. Although protected as a national park, illegal encroachment and exploitation of natural resources continues. Given the site's status, it should be possible to reverse this situation. Score: 3

Potential education and cultural value. Has good tourist facilities, and receives many visitors. Score: 1

Conservation momentum. Already has national park status. Score: 0

Conservation value. Protected as a national park. Score: 1

Total Score: 41
Ranking: 2

6.10 Lang Sen

General description. Lang Sen (10°44'-10°48'N 105°45-105°48'E; Map 10) constitutes the only area visited where *Melaleuca* swamp occurs along a natural river channel, and as such is of biodiversity value. The site described in the document proposing the establishment of a nature reserve at Lang Sen comprises 3,280 ha, but over half of this is cultivated for rice. The area of *Melaleuca* and open swamp comprises just over 1,000 ha.

Acidification of soil appears to be severe, with pH measurements of as little as 3.5 in the main river channels.

Status. The status of Lang Sen is not clear. The areas of *Melaleuca* plantation remaining are commercial Production Forest, but adjacent areas of *Melaleuca* scrub and swamp do not appear to have any official status. The site is managed by the district people's committee.

Flora. Patches of semi-natural *Melaleuca* forest were found in some swampy areas together with *Syzygium* spp., *Elaeocarpus hygrophilus*, *Ficus microcarpa*, and *Cassia grandis*. *Melaleuca* plantations reached 9 m in height and 8 cm in DBH. The ground layer included *Lasia spinosa*, *Cayratia trifolia* and *Flagellia indica*. Patches of young *Melaleuca* often occurred with *Eleocharis dulcis* and other grasses, including *Hymenachne acutigluma* and *Coix aquatica*.

This site included substantial areas of lotus swamp, a vegetation type characteristic of the Plain of Reeds, but which is now seldom found to any great extent. Lotus *Nelumbo nucifera*, as well as *Nymphaea nouchali*, *N. pubescens* and *N. tetragona* dominated this community. *Eleocharis dulcis*, *Ludwidgia*

adscendens, *Centrostachys aquatica*, *Hymenachne acutigluma*, *Coix aquatica* and *Leersia hexandra* also occurred in this community.

Birds. Bird species richness and abundance were rather low: only 61 species were recorded and many of these were represented by only a few individuals. Wetland-dependent birds in particular were scarce, with only some of the commonest waterbird species (e.g. Little Cormorant, Chinese Pond Heron, Cinnamon Bittern *Ixobrychus cinnamomeus*, Yellow Bittern *I. sinensis,* Black Bittern, and Spot-billed Duck) being represented by 10 or more birds. Many other species recorded were common residents of areas of scrub throughout the delta.

Threats and conservation recommendations. The area of habitat with high biodiversity value is quite small. Furthermore, as the site does not yet have any effective protection, exploitation of the remaining areas of *Melaleuca* forest continues. The river channel and adjacent canals have high levels of boat traffic and many people live in and around the site. As a result, the current levels of exploitation at the site are unsustainable. The provincial authorities have expressed an interest in establishing a protected area, and have produced a management plan. However, no significant protection has yet been offered the site: between survey visits an area of approximately 2 ha of mature *Melaleuca* plantation was felled. Furthermore, areas of rice agriculture and human settlement surround the site, so that encroachment into the central area of the site, which has the greatest biodiversity value, is frequent.

We recommend the following conservation action:

- Establishment of on-site headquarters to house management staff and equipment;
- Site boundary marking to enable local people and site management staff to identify the site;
- Cessation of *Melaleuca* harvesting; and
- Enforcement of measures to prevent unsustainable levels of exploitation of wetland resources at the site.

Criteria scores for Lang Sen.

Area. 3,280 ha. Score: 4

Diversity (species).
Shannon's Diversity Index: 2.429. Score: 2
Species richness: 61 species. Score: 4
Uniqueness: 5.234. Score: 1
Taxonomic relatedness: 3.63. Score: 1

Diversity (habitats). Four habitats recorded. Score: 2

Rarity (species). No rare species recorded. Score: 0

Rarity (habitats). *Melaleuca* swamp along a natural river course. Score: 1

Species congregation. No species represented by 1% of its population. Score: 0

Naturalness. Natural river course. Score: 1

Fragility. No fragile habitats. Score: 0

Special role in maintaining biological diversity. No bird species confined to the site. Score: 0

Position as an ecological unit. Surrounded by rice cultivation. Score: 0

Conservation management potential. Given the lack of a protected area and the willingness of provincial authorities to establish one, there is considerable scope for NGO involvement. Score: 3

Potential education and cultural value. None. Score: 0

Conservation momentum. Not currently a protected area but has attracted local government support. Score: 1

Conservation value. Not currently a protected area and few restrictions on access. Score: 0

Total Score: 20
Ranking: 9

6.11 Bird colonies

In all, 20 waterbird species were found in breeding colonies in the delta, and a minimum of 32,536 individual birds were recorded in total (Table 4). Four species constituted 88% of all birds recorded: Little Cormorant (15.3%), Little Egret (31.2%), Cattle Egret (28.1%) and Black-crowned Night Heron (13.2%). Three globally near-threatened species were recorded (Black-headed Ibis, Oriental Darter and Asian Openbill). The largest colony was in U Minh Thuong, where the total of over 5,500 birds was likely to have been a considerable underestimate. Bac Lieu had fewer birds but supported the greatest number of species (17), including more than 3% of the world population of Indian Cormorant.

Evaluation. Although it was not possible to visit all the bird colonies of the delta, the prime colonies were located by consultation with local authorities. Some bird colonies were included in larger wetland sites (e.g. U Minh Thuong, Tra Su) and are detailed above. Here, the discrete bird colonies visited are described and evaluated (Table 11).

Bac Lieu Nature Reserve. Bac Lieu Nature Reserve, Bac Lieu province is the largest by area of all the bird colonies in the delta, comprising 132 ha. A substantial colony of breeding waterbirds is found here, comprising one of the most important in the delta. Of particular note were four juvenile Black-headed Ibis, one Oriental Darter and several hundred Indian Cormorant. The site may be particularly important for the latter: the species was recorded in only small numbers at other sites, and the number recorded (930) constitutes over 3% of the global population of this species according to the latest population estimates available (Wetlands International, unpublished data).

Much of the nature reserve is wooded and several woodland bird species were found here, including White-rumped Shama *Copsychus malabaricus* (not found at any other site in the delta) and Rufescent Prinia *Prinia rufescens* (only recorded at one other site).

This site is decreed as a nature reserve together with two bird sanctuaries in Ca Mau province, which in

total cover 500 ha. However, the area of each of the decreed sites and the locations of the two sites in Ca Mau province are not clear.

Tra Cu bird sanctuary. Tra Cu bird sanctuary is a very small (c. 2 ha) bird sanctuary in the grounds of a pagoda in Tra Vinh province. Despite its size, it is one of the most important breeding colonies in the delta. The most notable feature is a substantial breeding population of the globally near-threatened Black-headed Ibis; at least 50 individuals were present during both visits, including juvenile birds in July. Also of importance was a large roosting population of Glossy Ibis, of which 300 were recorded in February. Only small numbers were present in July however, suggesting that the breeding population may be small. The figure of 300 Glossy Ibis may represent more than 1% of the South-East Asian population of this species (Wetlands International, unpublished data). The site is protected and managed by the monks who live in the pagoda complex.

Chua Hang bird sanctuary. Chua Hang is another small bird sanctuary located in the grounds of a pagoda, a few kilometres outside Tra Vinh town in Tra Vinh province. Large numbers of birds congregate here to roost and there is a substantial breeding colony of some of the commoner wetland species. Of most interest were five roosting Oriental Darters, although breeding could not be confirmed. The site is protected and managed by the monks who live in the pagoda complex.

Vam Ho bird sanctuary. A small area of Vam Ho Production Forest, Ben Tre province, has been set aside as a bird sanctuary by provincial authorities, and is managed by the provincial FPD. The sanctuary is in an area of *Nypa fruticans* and mangrove, and consists of only c. 5 ha. A total of just over 1,000 birds recorded in July comprised mainly Little Egret, Cattle Egret and Black-crowned Night Heron. Small numbers of Javan Pond Heron appear to breed here. A single Pacific Reef Egret *Egretta sacra* was located in the colony, and this species may breed here. This was the only location where this species was recorded in the Mekong Delta.

Ca Mau bird sanctuary. Ca Mau Bird Sanctuary, Ca Mau province, is another small bird sanctuary of only c. 2 ha in size. The colony held large numbers of the commoner wetland birds, including Little Cormorant, Little Egret and Cattle Egret. A single Oriental Darter and two Glossy Ibis were noted in August. The site was established and is managed by the people's committee of Ca Mau town as a 'culture park'.

Thoi An bird sanctuary. Thoi An bird sanctuary, Can Tho province, is a small bird sanctuary of c. 2 ha that holds several thousand breeding waterbirds. However, only three species breed here: Little Cormorant, Little Egret and Cattle Egret. The latter two species were represented by more than 1% of the regional population. Local people, who have established it as a tourist attraction, manage the site.

Duyen Hai bird sanctuary. Duyen Hai, Tra Vinh province, is a small bird sanctuary managed and protected by local families. Over 2,000 birds, mainly egrets and Little Cormorants roosted here, and breeding reportedly takes place in the wet season. The site holds more than 1% of the regional population of Little Egret. The count of 100 Great Egrets *Casmerodius albus* was one of the highest of any sites in the delta.

Table 11: Evaluation of discrete bird colonies on the basis of size, threatened species present and significant concentrations of individual species.

Site	Area (ha)	Rare species	Population concentrations (1% or more)	Score
Bac Lieu	132	Black-headed Ibis (NT) Oriental Darter (NT)	Indian Cormorant Purple Heron	**6**
Ca Mau	2	Oriental Darter (NT)	Little Cormorant Little Egret Cattle Egret	**5**
Tra Cu	2	Black-headed Ibis (NT)	Little Egret Glossy Ibis	**4**
Chua Hang	2	Oriental Darter (NT)	Little Egret Cattle Egret	**4**
Duyen Hai	2	None	Little Egret	**2**
Thoi An	2	None	Cattle Egret	**2**
Vam Ho	5	None	None	**1**

Many of the discrete bird colonies evaluated are managed by local people, often without government support. In the case of the small colonies this is the most effective means of protection, as often the site only exists at all because local people have acted to protect it. For these sites we recommend that protection remain in the hands of those currently managing the sites. Only Bac Lieu has status as a decreed nature reserve, which is more appropriate given the size of the site and the importance of the breeding colony there, and we recommend that this site receives continued support at a national level.

Table 12: Summary of rankings of 10 priority sites for conservation in the Mekong Delta.

Criteria	Lung Ngoc Hoang	Bai Boi	Dat Mui	Vo Doi	Tra Su	Tinh Doi	Ha Tien	U Minh Thuong	Tram Chim	Lang Sen
Area	4	4	4	5	3	4	5	5	4	4
Diversity (birds) as:										
Diversity index	1	1	2	2	1	2	1	2	1	2
Species richness	3	3	4	5	4	4	4	5	5	4
Uniqueness	1	3	3	1	1	1	2	1	1	1
Relatedness	1	0	0	1	1	1	1	1	1	1
Diversity (habitats)	3	3	2	2	2	2	4	3	2	2
Rarity (species)	0	6	10	0	3	1	7	4	7	0
Rarity (habitats)	1	1	1	2	1	1	1	2	1	1
Species congregation	0	1	2	0	0	0	5	9	5	0
Naturalness	1	0	0	2	1	1	1	2	1	1
Fragility	1	0	0	1	1	1	1	1	1	0
Special role	0	0	2	4	1	3	4	4	7	0
Position as ecological unit	0	1	1	1	0	0	1	0	0	0
Conservation Potential	1	2	1	2	1	1	3	0	3	3
Educational / cultural value	0	1	1	0	0	0	1	0	1	0
Conservation momentum	1	1	1	1	1	1	1	0	0	1
Conservation value	0	1	1	1	1	1	0	1	1	0
Total	**18**	**28**	**35**	**30**	**22**	**24**	**42**	**40**	**41**	**20**
Ranking	**10**	**6**	**4**	**5**	**8**	**7**	**1**	**3**	**2**	**9**

7. A strategy for sustainable management of wetlands in the Mekong Delta

To fulfil the commitments made under the CBD and Ramsar Convention, an overall strategy for sustainable wetland resource management in the Mekong Delta is required. This needs to address three main issues: the wetland protected area network in the Mekong Delta; government policy; and direction of donor support. The BirdLife International Vietnam Programme and the Institute of Ecology and Biological Resources have developed such a strategy on the basis of the findings of this project.

7.1 Wetland protected areas

As part of this strategy, it is necessary to create a representative network of wetland protected areas, both in terms of habitat representation and overall coverage.

The establishment and gazettement of new protected areas. In this project we have identified the priority sites for biodiversity conservation in the Mekong Delta. Of the 10 sites selected for the detailed phase 2 study, the highest priority for conservation action was the Ha Tien plain (Table 12). The top six sites were found to be of particularly high importance, fulfilling the criteria for designation as wetlands of international importance under the Ramsar Convention. The sites that qualify for this designation are Bai Boi and Dat Mui (which would best be considered a single continuous site), Vo Doi together with the proposed extension area, U Minh Thuong, Ha Tien and Tram Chim.

Vietnam is already committed to the creation of a representative network of protected areas under the CBD and Ramsar Convention. The BAP for Vietnam requires Vietnam to:

'Carry out the selection, planning and establishment of a number of important wetlands in the identified areas [with high biodiversity values].'

Under Resolution VII.11 of the Ramsar 7th Conference of the Contracting Parties (May 1999), Vietnam undertook a commitment:

'when identifying priority sites for designation…. to ensure that suitable transboundary wetlands and those providing important habitat for migratory wetland-dependent species are given prominence in these considerations.'

The government of Vietnam has acknowledged the importance of the Mekong Delta for biodiversity conservation and five nature reserves have so far been established: Tram Chim National Park, and nature reserves at Bac Lieu, U Minh Thuong, Vo Doi and Dat Mui. However, most of these protected areas are small and do not fully represent the biodiversity and habitat types found in the Mekong Delta. These sites cover only 39,389 ha out of the entire delta area of more than 3.9 million ha, and the area of decreed nature reserve actually covers only 22,509 ha. They therefore constitute less than 1% of the total area of the Mekong Delta (Map 11).

Furthermore, of the area of land under the currently protected area network, 43% is coastal mangrove and mudflat and 56% is *Melaleuca* forest, seasonally inundated grassland and swamp, and significant areas of seasonally inundated grassland are only represented at three sites (Tram Chim National Park, U Minh Thuong Nature Reserve and Vo Doi Nature Reserve). Of the 10 priority sites identified in this project, just 17% of the area is coastal mangrove and mudflats, while 83% is *Melaleuca* forest, seasonally inundated grassland and swamp. Furthermore, the existing network covers 97% of the area of the priority coastal sites, while only 44% of the area of priority freshwater sites is covered. There is therefore

a clear bias towards protection of coastal sites. Freshwater sites are poorly represented, particularly those including substantial areas of seasonally inundated grassland.

To establish a more balanced and representative network of protected areas, we recommend the establishment of the following sites as new nature reserves:

- **Ha Tien.** All areas of grassland and *Melaleuca* remaining between 10°20'-10°29'N and 104°32'-104°39'E constituting 6,981 ha (indicated by the survey area boundary shown in Map 7a);

- **Kien Luong.** The area of grassland and *Melaleuca* between 10°09'-10°17'N and 104°34'-104°42'E, constituting 7,624 ha (indicated by the survey area boundary shown in Map 7b); and

- **Bai Boi.** This site should be re-zoned as Special-use Forest and made a nature reserve, comprising 5,525 ha. The western boundary of the nature reserve should be defined as the low water mark, as this will encompass any mudflat emerging as a result of accretion in the future.

We also recommend the extension of the following nature reserves:

- **Vo Doi.** The decreed nature reserve constitutes 2,000 ha, though the site managed by the FPD covers 3,724 ha. The nature reserve should be extended to include the whole of this area, as well as the adjacent areas of Tran Van Thoi and U Minh III (see Map 4), as has been proposed by the provincial authorities. The nature reserve would then comprise 10,991 ha;

- **Dat Mui.** The current decree covers 4,000 ha, though the provincial FPD manage an area of 4,388 ha of Special-use Forest, of which only 1,717 ha is treated as 'strictly protected'. The nature reserve should be extended to cover all areas of mangrove and mudflats, which constitute 6,031 ha; and

- **U Minh Thuong.** The decree for this nature reserve covers 8,504 ha of the core zone. The buffer zone of some 13,000 ha, including the *Melaleuca* plantation holding the largest waterbird colony in the delta, is not included. The nature reserve should be extended to incorporate the waterbird colony and the buffer zone should be managed as part of the nature reserve area.

These new nature reserves and extensions would increase the total area of the Mekong Delta protected as decreed nature reserve by 45,561 ha, from 22,509 ha to 68,070 ha. The total protected area would then constitute 1.7% of the total land area of the delta.

Additionally, the following sites should initially be given protection as nature reserves at the provincial level, with the possibility of becoming nationally decreed nature reserves at a later date.

- **Tra Su.** This site is small, and the main area of biodiversity value is restricted to the remaining 175 ha of seasonally inundated grassland and swamp, and the waterbird colony. It seems unlikely that the status of the site as Production Forest will be changed, but protecting part of the site is feasible, and this should be carried out at the provincial level.

- **Tinh Doi.** The main biodiversity value of this site is restricted to the remaining areas of

seasonally inundated grassland and swamp, constituting less than 500 ha. It seems unlikely that the status of the site as Production Forest will be changed, but protecting part of the site is feasible, and this should be carried out at the provincial level.

- **Lang Sen.** Provincial authorities have expressed a desire to establish this site as a protected area, but as the site is small and currently exposed to levels of exploitation that are probably unsustainable, establishment of a nature reserve at a national level may not currently be feasible.

- **Lung Ngoc Hoang.** The main biodiversity value of this site is restricted to the remaining areas of seasonally inundated grassland and swamp, constituting only c. 650 ha. Provincial authorities have expressed a desire to establish this site as a protected area, but as the site is currently exposed to levels of exploitation that are probably unsustainable, establishment of a nature reserve at a national level may not currently be feasible.

Wetland rehabilitation. Even allowing for the proposed and extended nature reserves, many of the protected areas are small by international standards, and some may not provide enough habitat to maintain viable populations of flora and fauna. In such cases, there is a need to investigate the possibility of wetland rehabilitation. For all the sites identified as suitable for gazettement only at the provincial level, wetland rehabilitation in the future could increase the biodiversity value of the sites to make national-level designation appropriate.

Management plans for newly gazetted sites. To secure the long-term conservation of biodiversity, detailed management plans advocating realistic resource management strategies for all protected areas are essential. Although many of the sites proposed here have management plans, they do not fully address the need for conservation management, nor take into account the linkages between the site and the surrounding area.

7.2 Policy shifts required

There are several aspects of government policy that need to be addressed if the values of wetlands, especially freshwater, are to be recognised in agricultural policy planning.

The formulation of a national wetlands strategy. Wetland biodiversity cannot be conserved in protected areas alone, as they are inextricably linked to the man-made wetlands surrounding them. For example, flooding and flow regimes mean that water quality of a protected area can be influenced greatly by that surrounding it. Similarly, although protected areas provide an essential refuge for wildlife, adjacent areas may also provide important feeding or roosting areas. These linkages need to be recognised and managed, ensuring that sustainable populations of wildlife are conserved and that the ecosystem functions on which people are dependent are maintained. Furthermore, the threats to wetlands in the Mekong Delta are likely to interact synergistically, illustrating the need for a national wetland policy, so that threats can be addressed together rather than in isolation.

The identification of a national government wetlands authority. Currently, several different government ministries have some responsibility for wetlands, including MARD, MoSTE, and MoF. As a result, it has not been possible to effectively tackle the conservation issues facing the Mekong Delta. To manage and designate a representative wetland protected area system in the Mekong Delta, the consolidation of wetland management and conservation under a single management authority is necessary. Such an authority should be given a clear mandate to pursue sustainable development and wise use of wetlands throughout the country.

A cross-sectoral National Wetland Committee should be established, with stakeholder representatives from all sectors (government, non-government and private sector). A single authority should be given overall responsibility, which would act as a secretariat for the National Committee. This single authority should be MoSTE, which is already the Ramsar Administrative Authority and is the key organisation in implementing the Biodiversity Action Plan for Vietnam.

Fulfilment of the obligations Vietnam has under international conventions and agreements. The BAP for Vietnam stresses that 'wetlands in Vietnam suffer because they have not been placed under an agency's responsibility.' It also notes that 'some of Vietnam's most precious species and many of Vietnam's endangered species are wetland dwellers, so serious attention must be paid to conserving these areas.' Furthermore, the BAP highlights the need for 'a detailed wetland conservation and management strategy….to help take actions needed to safeguard these wetlands.'

This is explicitly required under Project M29 'Wetlands Conservation Strategy' of the BAP. The World Conservation Union (IUCN) has been working with the National Environment Agency of MoSTE, to produce such a strategy, and the completion of this is an urgent priority for establishment of a national wetlands policy and management authority.

Vietnam also has a commitment under the Ramsar Convention, to 'include wetland conservation considerations within its national land-use planning, and to formulate and implement this planning so as to promote, as far as possible, the wise use of wetlands in its territory'. The convention also requires the designation of wetlands of international importance. Six wetlands in the Mekong Delta satisfy a number of the criteria used under the Ramsar Convention and should be notified, four of which are freshwater sites.

Ramsar criteria satisfied include wetlands which should be considered internationally important if they:

- Contain a representative, rare, or unique example of a natural or near-natural wetland found within the appropriate biogeographical region (Tram Chim, Ha Tien, U Minh Thuong, Vo Doi);

- Support vulnerable, endangered or critically endangered species or threatened ecological communities (Tram Chim, Ha Tien, U Minh Thuong, Bai Boi, Dat Mui); or

- Regularly support 1% of the individuals in a population of one species or subspecies of waterbird (Bai Boi, Dat Mui, Tram Chim, Ha Tien, and U Minh Thuong).

Resettlement policy. Resettlement of people in wetland habitats and uncontrolled conversion of wetlands for marginal agricultural uses are the major negative impacts on biodiversity conservation and sustainable resource use in the Mekong Delta. Prime Minister Resolution No. 815/TTg (12 December 1995), on the 'Planning and establishment of inhabitant areas in the Mekong Delta' states that:

'Based on the general planning of the Mekong Delta region and each province, [resettlement] planning has to adapt to the economic, social and natural conditions and orientations of development in each area in each period, to guarantee the balance between all aspects such as the economy, and the social and ecological environment'.

Resettlement has thus been driven by specific government policies compounded by economic pressures on people living throughout Vietnam. Many new settlers are not originally delta inhabitants, but are

forced to find land in the remaining areas available in the delta. This has resulted in agricultural conversion in unsuitable areas, despite the requirement to guarantee the balance of the ecological environment, and despite the decree specifically highlighting the fact that:

- 'When relocating people, particular attention should be paid to moving people who are living in difficult natural and economic conditions, such as in low-lying swamp lands, areas of acid-sulphate grasslands, brackish areas etc.'

However, relocation of people *into* areas of acid-sulphate grassland and subsequent conversion of grassland to paddyfields with very low productivity has been occurring and is a serious threat to biodiversity conservation and ecological integrity in Mekong Delta wetlands.

There is therefore a need for these policy initiatives to be implemented in a way that takes into account the requirements under them for maintaining the ecological balance. It may also be necessary to draft new legislation that specifically requires the wise and sustainable use of wetland ecosystems.

Capacity-building amongst government organisations. To effectively carry out a change in attitudes towards wetlands, capacity building and training amongst government organisations is necessary. Currently, most protected area management staff are trained in forestry. Training programmes designed to improve management skills as well as understanding of the problems faced in wetland conservation are therefore needed.

7.3 Direction of donor support

Within the wetland environment, an overemphasis has to date been made on coastal projects by donors. Most of the major environmental projects carried out in the delta so far have centred on the coastal zone (e.g. Euroconsult *et al*. 1996). These have led to wide-scale replanting of mangrove forests, with varying impacts on biodiversity conservation, and establishment of management plans for coastal protected areas. However, less attention has been given to freshwater wetlands, and very few major donor projects have so far been implemented to support protection of specific sites or to encourage sustainable use of freshwater wetlands.

Donor support in the future should therefore seek to redress this balance by supporting conservation and sustainable management of freshwater wetlands. The problems experienced in freshwater sites are often very different to those of coastal sites, where the benefits of maintaining mangrove forest and breeding grounds for economically important organisms are sometimes easier for local people to recognise. Donors, NGOs and government departments need to work together to produce solutions for these problems in freshwater wetlands.

8. Conclusions

As human population and development pressures increase in the Mekong Delta, the need to regulate current natural resource use to ensure it remains within sustainable levels becomes a vital economic prerequisite for continued wealth generation. In addition, planning future land-use becomes an ever-greater imperative, so that the long-term viability of ecosystems is maintained, which will in turn maintain the economic and social fabric of the area. Failure to adequately conserve and manage 'pockets' of biodiversity will result in a totally anthropogenic ecosystem supporting minimal biodiversity. Spawning areas for fish, frogs and other economically important organisms will be lost. Genetic material for crop improvement, medicinal plants and those with artisan value (for weaving and thatching) may also be lost. Furthermore the loss of such species from the delta may impair their ability to re-colonise following future land-use changes. Reserves of biodiversity can further act as sinks for the highly eutrophic and pesticide-contaminated waters of the delta, thereby maintaining basic ecosystem functions. In short, although their economic value is not currently quantified, the contributions made by natural and semi-natural habitats would appear vital in maintaining the agricultural and aquacultural output of the Mekong Delta. This is in addition to the more traditionally acknowledged range of benefits, such as conserving fauna and flora, which protected areas provide.

Currently, the nature reserves in the Mekong Delta protect neither a sufficient proportion of the wetland area nor a representative selection of habitats present. In addition, the wetland ecosystem outside protected areas is currently widely exploited in an unsustainable way. We recommend that all wetlands in the Mekong Delta should be managed sustainably and wisely in accordance with Vietnam's obligations under the CBD and the Ramsar Convention.

An urgent priority is for the establishment of two new nature reserves in the Ha Tien plain. We have shown this to be the main priority area for conservation action, and if no action is taken now it is likely that the biodiversity value of this area will be lost. Another new nature reserve should be established at Bai Boi.

Of the six sites found to be particularly high priorities for biodiversity conservation (Ha Tien, Tram Chim, U Minh Thuong, Vo Doi plus extension, Bai Boi and Dat Mui), five already have been designated as protected areas, though only in the case of Tram Chim does this encompass the entire site. The situation at the four other nature reserves needs to be clarified, and where necessary the decreed area should be extended to cover the full biodiversity importance of the sites.

All of the six high priority sites satisfy at least two of the criteria under the Ramsar Convention as wetlands of international importance. We fully support the proposal by Dong Thap provincial authorities that Tram Chim National Park be designated a Ramsar site. We also urge provincial authorities in Kien Giang and Ca Mau to propose the designation of the remaining five sites listed above. Dat Mui and Bai Boi also meet the criteria for notification under the East Asian-Australasian Shorebird Site Network and urge that these sites be proposed for inclusion.

However, the designation of new and extended nature reserves is only part of the solution to the problem of biodiversity loss in the Mekong Delta. An overall strategic plan for wetland management, as identified in this document, is urgently needed.

References

Anon. (1994) *Biodiversity action plan for Vietnam*. Hanoi, Vietnam: Government of the Socialist Republic of Vietnam and the Global Environment Facility.

Anon. (1998) Biosphere reserve nomination form for Can Gio mangrove. Ho Chi Minh City, Vietnam: MAB-Vietnam National Committee & CRES.

Anon. (1999) Total foreign investment by sector. *Vietnam Economic Times* 63: 35.

Begon, M., Harper, J. L. and Townsend, C. R. (1996) *Ecology: individuals, populations and communities*. Oxford, U.K.: Blackwell Science.

Clarke, K. R. and Warwick, R. M. (1998) A taxonomic distinctness index and its statistical properties. *Journal of Applied Ecology* 35: 523-531.

Collar, N. J., Crosby, M. J. and Stattersfield, A. J. (1994) *Birds to watch 2: the world list of threatened birds*. Cambridge, U.K.: BirdLife International.

Corbet, G. B. and Hill, J. E. (1992) *The mammals of the Indomalayan region: a systematic review*. Oxford, U.K.: Oxford University Press.

Craven L. A. and Barlow, B. A. (1997) New taxa and new combinations in *Melaleuca* (Myrtaceae). *Novon* 7: 113-119.

Dang Huy Huynh (1998) Division of geo-biological regions and the system of special use forests in Vietnam. *Vietnamese Studies* 3: 109-120.

Duckworth, J. W., Davidson, P. and Timmins, R. J. (in press) Birds. In: J. W. Duckworth, R. E. Salter and K. Khounboline, eds. *Wildlife in Lao PDR: 1999 status report.* IUCN: Vientiane (Laos).

Duong Van Ni, Safford, R. and Maltby, E. (in press) Environment change, ecosystem degradation and the value of wetland rehabilitation in the Mekong Delta. In: M. Kelly, and N. Adger, eds. *Environmental change in Vietnam*, London, U.K.: Wiley.

Euroconsult, FIPI - 2 and RIA - 2 (1996) *Coastal wetlands protection and development, southern Mekong Delta*. Ho Chi Minh City, Vietnam: World Bank and Government of Vietnam.

General Statistical Office (1994) *Statistical yearbook*. Hanoi, Vietnam: Statistical Publishing House.

Inskipp T., Lindsey, N. and Duckworth, W. (1996) *An annotated checklist of the birds of the Oriental region.* Sandy, U.K.: Oriental Bird Club.

Le Cong Kiet (1993) Dong Thap Muoi - restoring the mystery forest of the Plain of Reeds. *Restoration and Management Notes* 11: 102-105.

Le Cong Kiet (1994) Native freshwater vegetation communities in the Mekong Delta. *International Journal of Ecology and Environmental Sciences* 20: 55-71.

Le Dien Duc (1989) Socialist Republic of Vietnam. Pp. 749-793 in D. A. Scott, ed. *A directory of Asian wetlands*. Gland, Switzerland: IUCN.

Lekagul, B. and Round, P. D. (1991) *A guide to the birds of Thailand.* Bangkok, Thailand: Saha Karn Bhaet Co. Ltd.

Ministry of Forestry (1991a) *Vietnam forestry sector review tropical forestry action programme: main report*. Hanoi, Vietnam: Ministry of Forestry.

Ministry of Forestry (1991b) *Vietnam forestry sector review tropical forestry action programme: forest policy and legislation*. Hanoi, Vietnam: Ministry of Forestry.

Nguyen Huu Chiem (1993) Geo-pedagogical study of the Mekong Delta. *Southeast Asian Studies* 31: 158 – 185.

Nguyen Van Nhan (1997) Wetland mapping in the Mekong Delta and Tram Chim National Reserve area using Geographical Information Systems. Pp. 87-94 in R. J. Safford , Duong Van Ni, E. Maltby and Vo-Tong Xuan, eds. *Toward Sustainable Management of Tram Chim National Reserve, Vietnam.* London, U.K.: Royal Holloway Institute for Environmental Research, University of London.

Pantulu V. R. (1986) Fish of the Mekong Basin. Pp. 721-741 in B. R. Davies and K. F. Walker, eds. *The ecology of river systems*. Dordrecht, Netherlands: Dr W. Junk.

Pedersen A. and Nguyen Huy Thang (1996) *The conservation of key coastal wetland sites in the Red River Delta.* Hanoi, Vietnam: BirdLife International Vietnam Programme.

Pham Hoang Ho (1991 - 1993) *Cay co Vietnam.* (3 volumes). Montreal, Canada: Mekong Printing.

Pham Trong Thinh (1997) Values, growth rates and status of *Melaleuca* forest in the Plain of Reeds. Pp. 81-86 in R. J. Safford , Duong Van Ni, E. Maltby and Vo-Tong Xuan, eds. T*oward sustainable management of Tram Chim National Reserve, Vietnam.* London, U.K.: Royal Holloway Institute for Environmental Research, University of London.

Ramsar Convention Bureau (1994) *The Ramsar Convention manual.* Gland, Switzerland: Ramsar Convention Bureau.

Ratcliffe, D. A. (1977) *A nature conservation review*. Vols. 1 and 2. Cambridge, U.K.: Cambridge University Press.

Safford R. J., Tran Triet, Maltby, E. and Duong Van Ni (in press) Status, biodiversity and management of the U Minh wetlands, Vietnam. *Tropical Biodiversity*.

Thewlis, R. M., Timmins, R. J., Evans, T. D. and Duckworth, J. W. (1998) The conservation status of birds in Laos: a review of key species. *Bird Conservation International* 8: 1-159.

Tran Triet (1999) *Freshwater wetland vegetation of the Mekong Delta, Vietnam: a study on the relationship between plant species distribution and the wetland environment*. Unpublished PhD thesis, University of Wisconsin.

Tran Triet, Safford, R. J., Duong Van Ni and Maltby, E. (in press) Wetland biodiversity overlooked and threatened in the Mekong Delta, Vietnam: grassland ecosystems in the Ha Tien plain. *Tropical Biodiversity*.

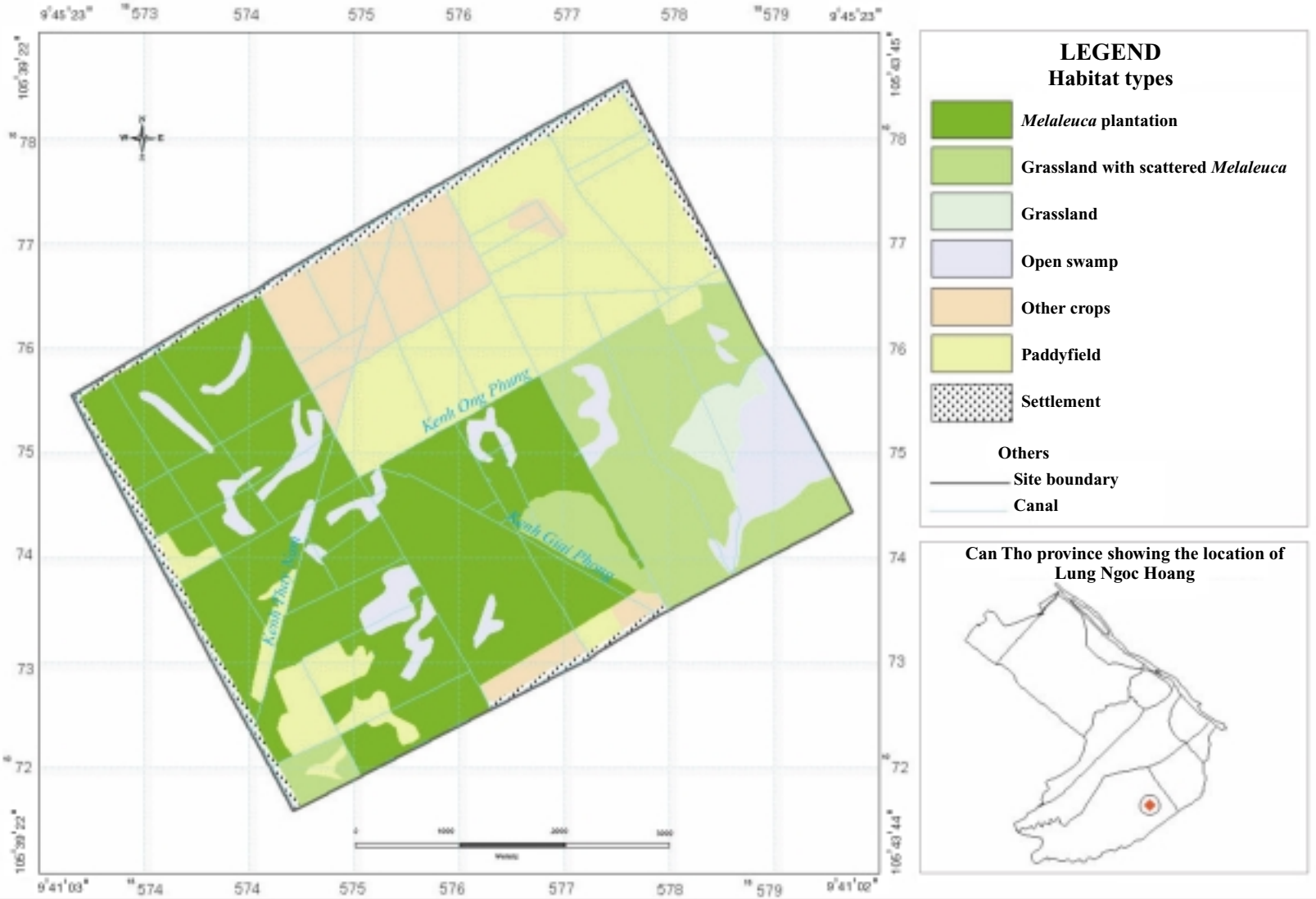
van Balen, B., Suwelo, I. S. Hadi, D. S., Soepomo, D., Arlon, R. M. and Mutiarina (1993) The decline of the Brahminy Kite *Haliastur indus* on Java. *Forktail* 8: 83-88.

Vietnam National Mekong Committee (1998) *An introduction.* VNMC, Hanoi.

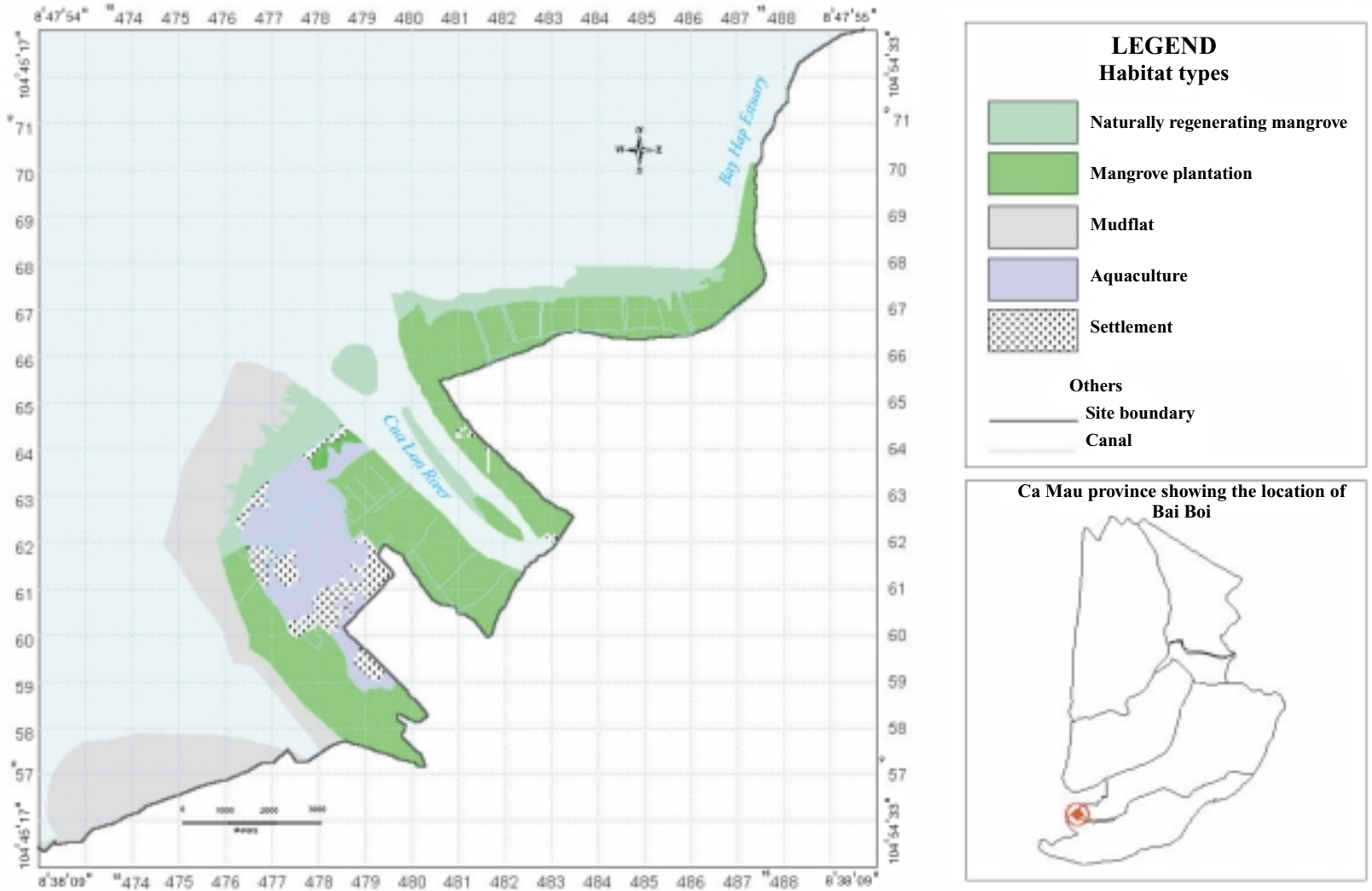
Warwick, R. M. and Clarke, K. R. (1998) Taxonomic distinctness and environmental assessment. *Journal of Applied Ecology* 35: 532-543.

Wege, D. C., Long, A. J., Mai Ky Vinh, Vu Van Dung and Eames, J. C. (1999) *Expanding the protected areas network in Vietnam for the 21st century: an analysis of the current system with recommendations for equitable expansion.* Hanoi, Vietnam: BirdLife International Vietnam Programme.

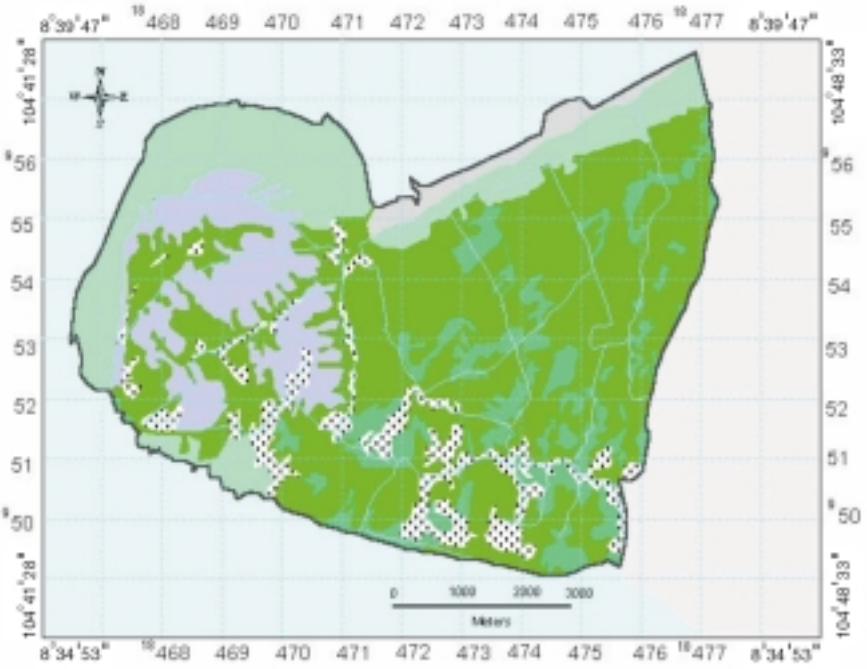
Map 1: Habitat map of Lung Ngoc Hoang



Map 2: Habitat map of Bai Boi



Map 3: Habitat map of Dat Mui Nature Reserve



LEGEND
Habitat types

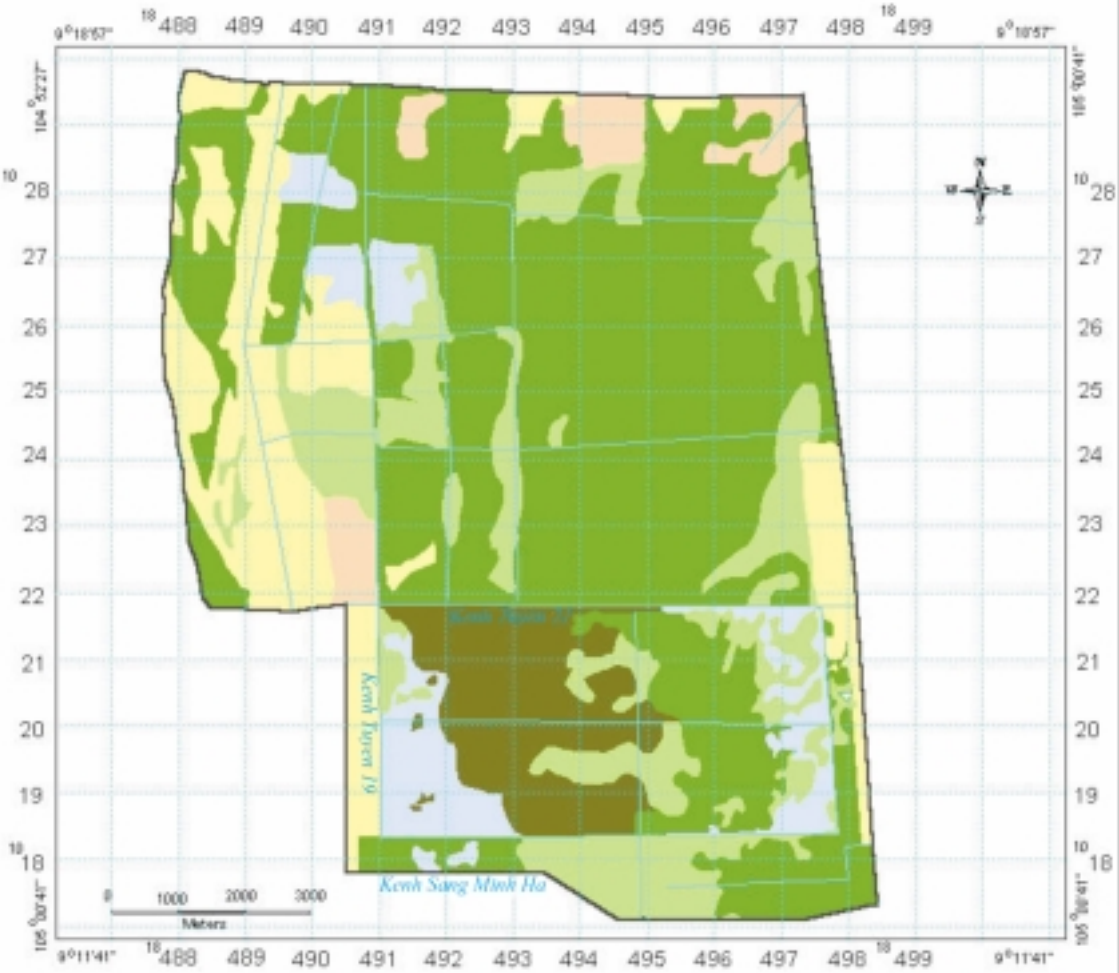
- Naturally regenerating mangrove
- Mangrove plantation
- Old growth mangrove (degraded)
- Mudflat
- Aquaculture
- Settlement

Others

- Site boundary
- Canal

Ca Mau province showing the location of Dat Mui

Map 4: Habitat map of Voi Doi Nature Reserve, Tran Van Thoi and U Minh III



LEGEND
Habitat types

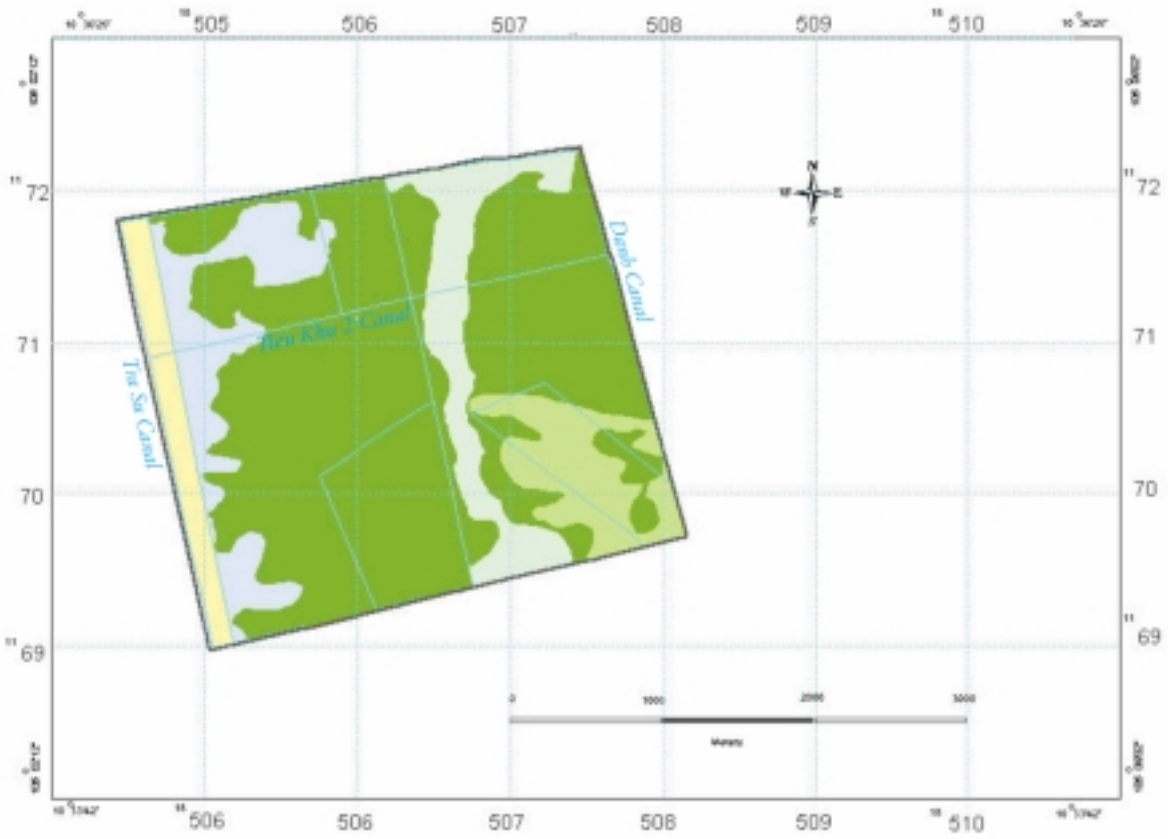
- **Semi-natural *Melaleuca* forest**
- ***Melaleuca* plantation**
- **Grassland with scattered *Melaleuca***
- **Open swamp**
- **Other crops**
- **Paddyfield**

Others

- **Site boundary**
- **Canal**

Ca Mau province showing the location of Voi Doi

Map 5: Habitat map of Tra Su



LEGEND
Habitat types

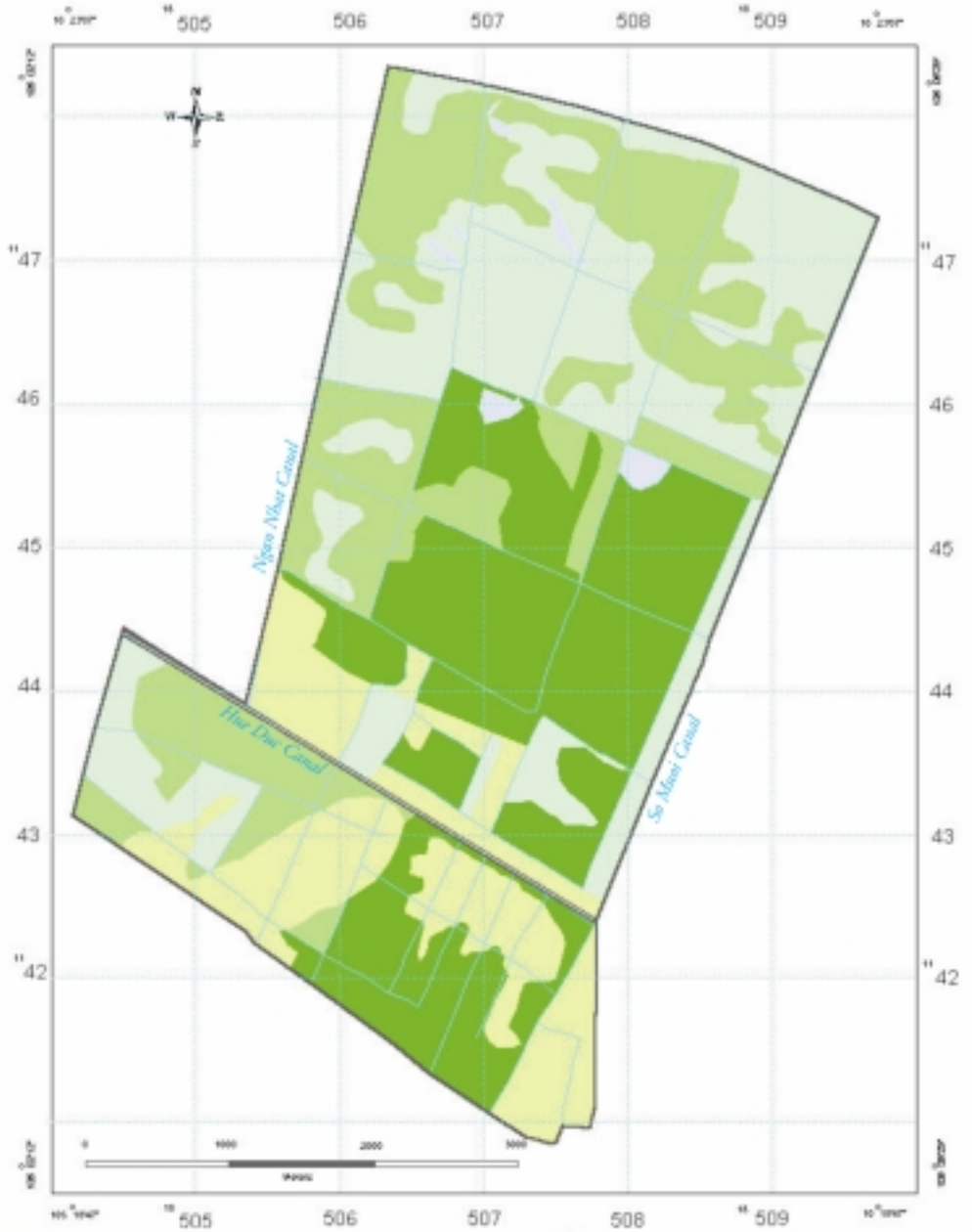
- ***Melaleuca* plantation**
- **Grassland with scattered *Melaleuca***
- **Grassland**
- **Open swamp**
- **Paddyfield**

Others

- **Site boundary**
- **Canal**

An Giang province showing the location of Tra Su

Map 6: Habitat map of Tinh Doi



LEGEND
Habitat types

- ***Melaleuca* plantation**
- **Grassland with scattered *Melaleuca***
- **Grassland**
- **Open swamp**
- **Paddyfield**

Others

- **Road**
- **Site boundary**
- **Canal**

An Giang province showing the location of Tinh Doi

Map 7a: Habitat map of Ha Tien

LEGEND

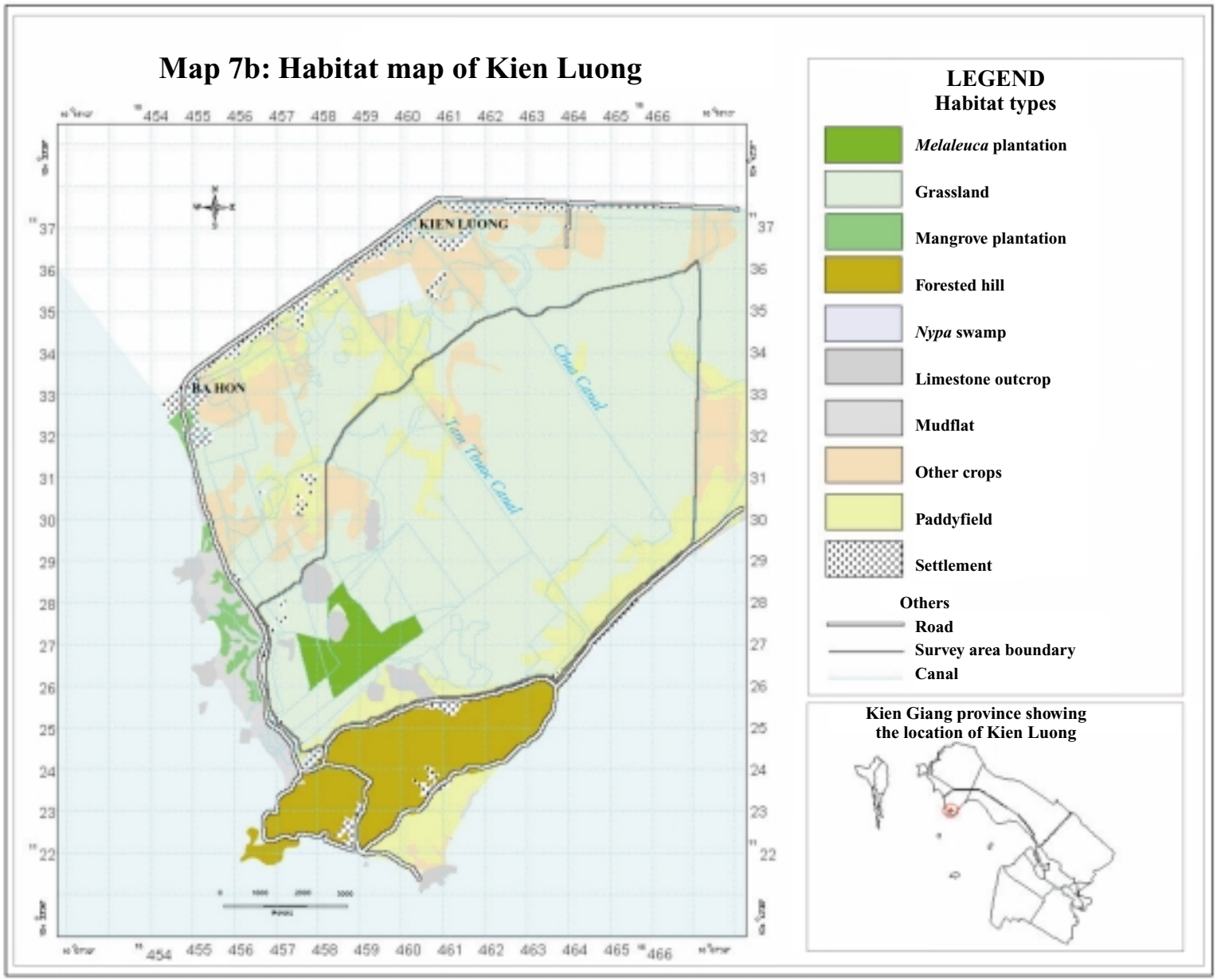
Habitat types

- *Melaleuca* plantation
- Grassland with scattered *Meleleuca*
- Grassland
- *Nypa* swamp
- Limestone outcrop
- Paddyfield
- Settlement

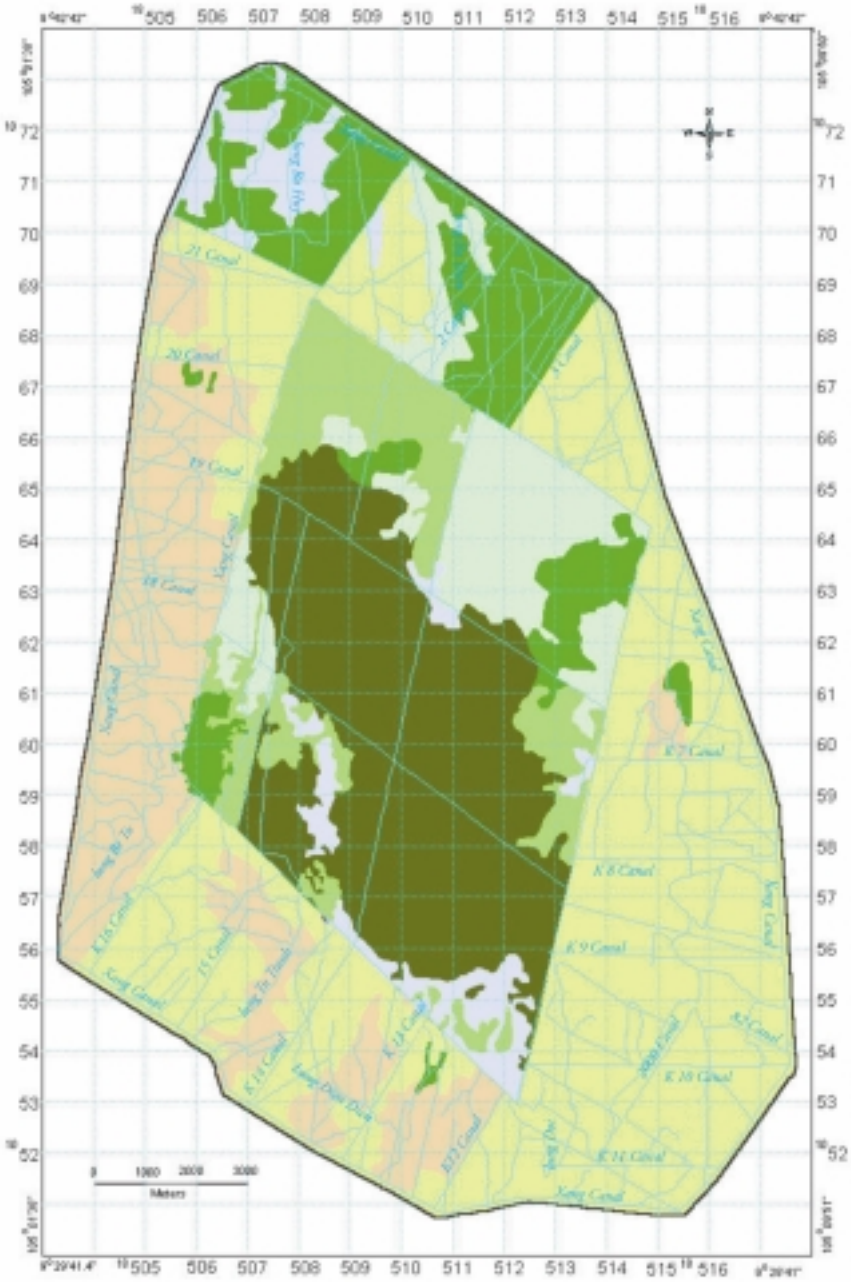
Others

- Road
- Survey area boundary
- Canal

Kien Giang province showing the location of Ha Tien


Map 7b: Habitat map of Kien Luong
LEGEND
Habitat types
Melaleuca plantation
Grassland
Mangrove plantation
Forested hill
Nypa swamp
Limestone outcrop
Mudflat
Other crops
Paddyfield
Settlement
Others
Road
Survey area boundary
Canal
Kien Giang province showing the location of Kien Luong
KIEN LUONG
BA HON
Chua Canal
Tam Hiep Canal
454 455 456 457 458 459 460 461 462 463 464 465 466
37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22

Map 8: Habitat map of U Minh Thuong Nature Reserve



LEGEND

Habitat types

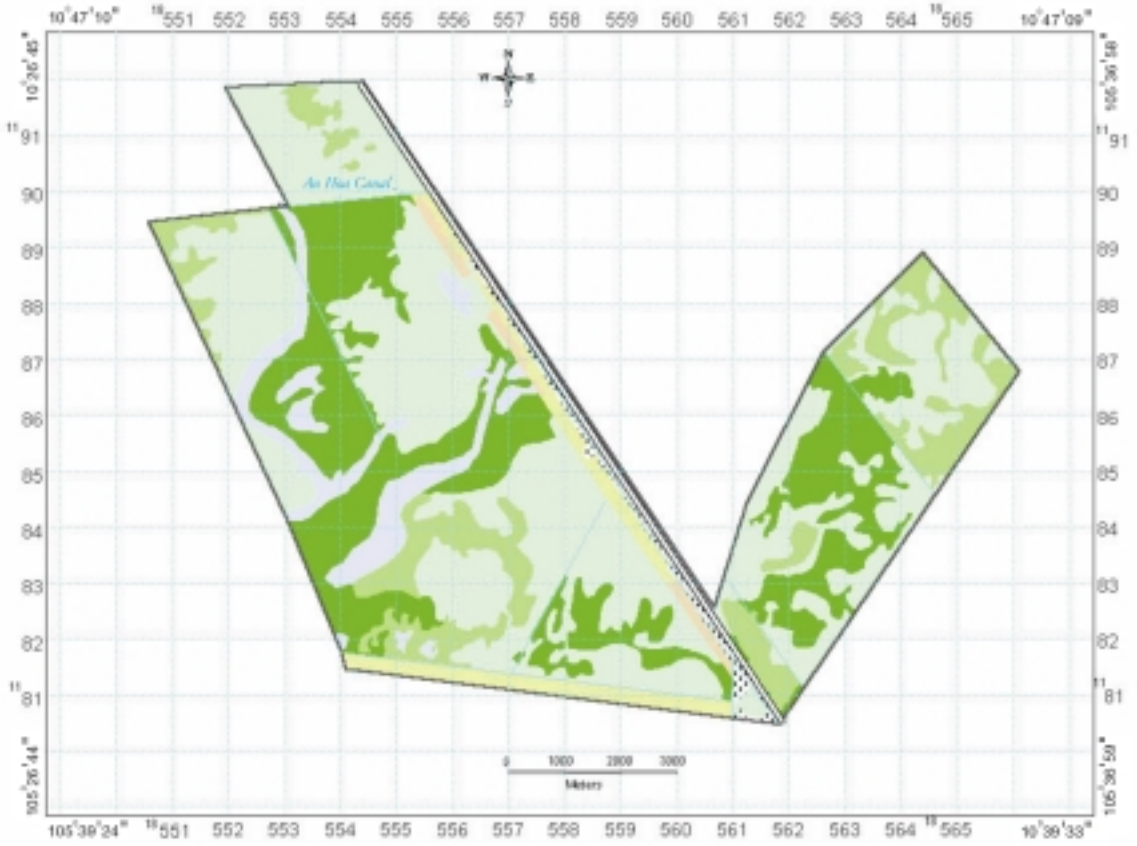
- Semi-natural *Melaleuca* forest
- *Melaleuca* plantation
- Grassland with scattered *Melaleuca*
- Grassland
- Open swamp
- Other crops
- Paddyfield

Others

- Site boundary
- Canal

Kien Giang province showing the location of U Minh Thuong

Map 9: Habitat map of Tram Chim National Park



LEGEND
Habitat types

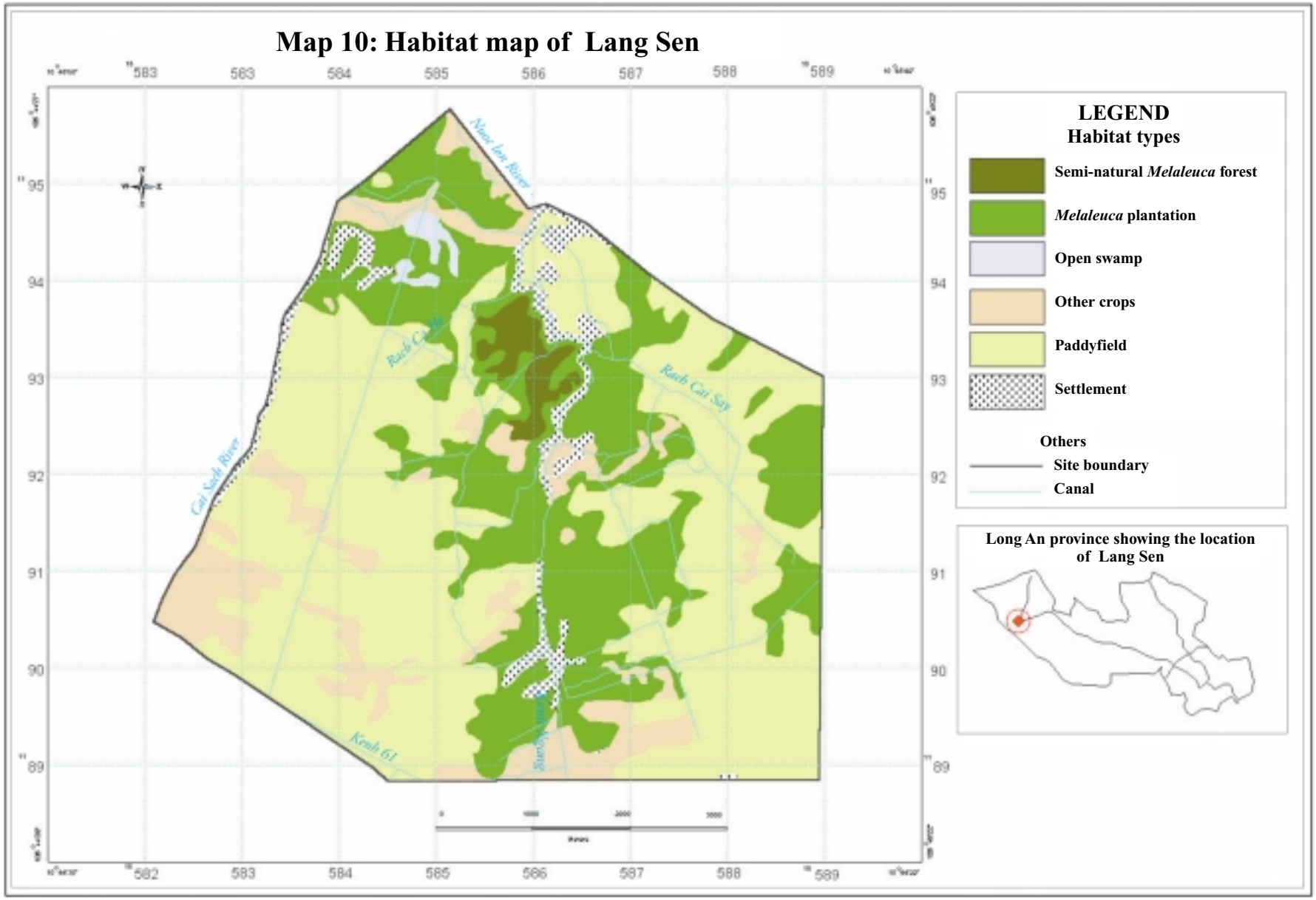
- ***Melaleuca* plantation**
- **Grassland with scattered *Melaleuca***
- **Grassland**
- **Open swamp**
- **Other crops**
- **Paddyfield**
- **Settlement**

Others

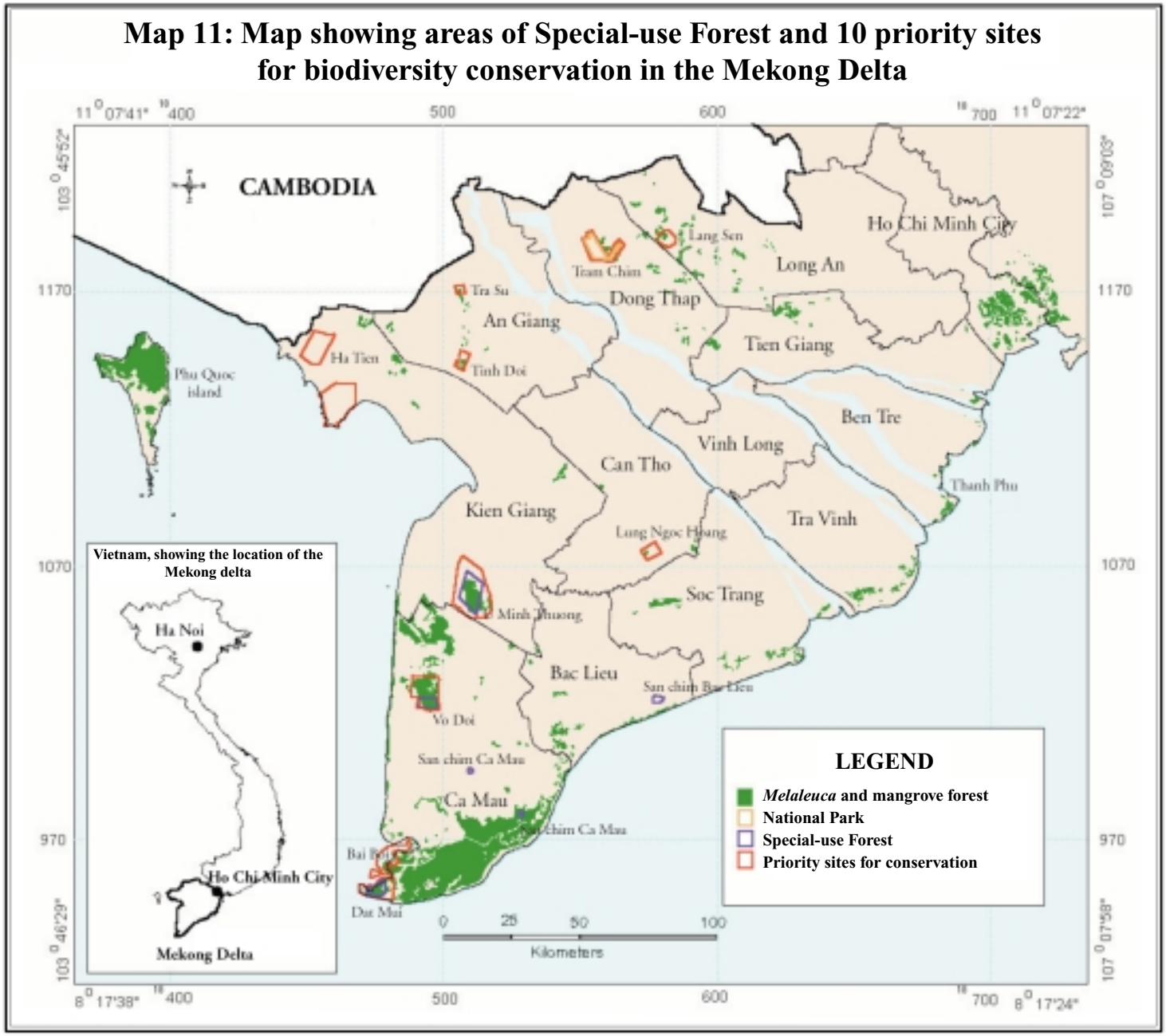
- **Road**
- **Site boundary**
- **Canal**

Dong Thap province showing the location of Tram Chim

Map 10: Habitat map of Lang Sen



Map 11: Map showing areas of Special-use Forest and 10 priority sites for biodiversity conservation in the Mekong Delta



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Appendix 2a: Wetland plant species in the Mekong Delta

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Acanthaceae											
Acanthus ebracteatus		+					+				
A. ilicifolius											+
Hygrophyla incana									+	+	
H. salicifolia			+				+	+			
Nelsonia campestris										+	
Ruellia macrosiphon							+				
Adiantaceae											
Acrostichum aureum		+	+				+	+			
Stenochlaena palustris	+		+					+	+	+	
Aizoaceae											
Glinus hernarioides					+					+	
G. lotoides				+	+					+	
Sesuvium portulacastrum		+					+				
Alismataceae											
Sagittaria sagittaefolia									+		
Amaranthaceae											
Alternanthera paronychioides		+					+	+			
A. sessilis								+		+	
Amaranthus spinosus	+	+	+	+	+	+		+	+	+	
Centrostachys aquatica	+									+	
Amarylliadaceae											
Crinum asiaticum											+
Anacardiaceae											
Buchannaria arborescens									+		
Annonaceae											
Annona glabra	+		+		+		+	+	+	+	
Apiaceae											
Centella asiatica	+	+	+	+	+	+		+	+	+	
Apocynaceae											
Alstonia spathulata			+					+			
Cerbera manghas											+
C. odollam							+	+			+
Aquifoliaceae											
Ilex cymosa			+					+	+		
Araceae											
Colocasia esculenta	+		+				+	+			
Cryptocoryne ciliata											+
Lasia spinosa									+		
Pistia stratiotes	+		+	+	+		+	+	+	+	
Araliaceae											
Aglaodora griffithii							+	+			
Arecaceae											
Nypa fruticans		+					+	+			
Oncosperma tigillaria											+

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Phoenix paludosa		+					+	+			
Asclepiadaceae											
Finlaysonia obovata		+									
Gymnanthera nitida							+	+			
Sarcolobus globosus							+	+			
Strepocaulon juventas										+	
Aspleniaceae											
Asplenium longisimum							+	+			
Asteraceae											
Adenostemma macrophyllum			+	+	+				+	+	
Ageratum conyzoides			+				+	+			
Blumea lacera							+	+			
Centipeda minita				+	+						
Eclipta prostrata			+				+	+		+	
Enydra fluctuans							+	+		+	
Eupatorium odoratum	+	+					+	+			
Grangea maderaspatana							+	+		+	
Pluchea indica		+					+	+			
Sphaeranthus africanus										+	
S. indicus	+						+	+		+	
Sphaeromorpha australis										+	
Spilanthes iabadacensis								+		+	
Thespis divaricata			+								
Vernonia cinerea							+	+			
V. elliptica							+	+			
Wedelia biflora		+					+				
Azollaceae											
Azolla pinnata	+						+	+		+	
Balsaminaceae											
Hydrocera trifolia							+	+		+	
Bignoniaceae											
Dolichandrone spathacea							+	+			
Boraginaceae											
Coldenia procumbens			+					+		+	
Heliotropium indicum							+			+	
Butomaceae											
Limnochais flava	+								+	+	
Cannaceae											
Canna glauca										+	
Ceratophyllaceae											
Ceratophyllum demersum				+			+	+		+	
Chenopodiaceae											
Suaeda maritima											+
Clusiaceaae											
Calophylum inophyllum							+		+		
Garcinia schomburgkiana									+		
Combretaceae											
Combretum acuminatum							+	+	+	+	

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
C. quadrangulare							+				
C. tetralophum											+
Lumnitzera littorea											+
L. racemosa							+				
Terminalia catappa											+
Commelinaceae											
Commelina communis							+				
C. diffusa							+	+			
C. longifolia			+						+	+	
C. paldusa	+			+	+			+	+	+	
Floscopa scandens							+				
Murdannia giganteum							+				
M. vaginatum							+				
Convolvulaceae											
Aniseia martinicensis	+		+	+	+		+	+	+	+	
Argyreia capitata							+				
A. mekongensis							+	+			
Ipomoea aquatica	+		+	+	+		+	+	+	+	
I. carnea							+				
I. eriocarpa									+		
I. longanensis									+		
I. pes-caprae							+	+			
Merremia hederaceae	+									+	
Cucurbitaceae											
Gymnopetalum cochinchinensis									+		
Zehneria indica			+				+	+			
Cuscutaceae											
Cuscuta australis			+		+						
Cyperaceae											
Cyperus alopecuroides							+				
C. arenarius							+				
C. babakans			+					+			
C. bulbosus							+				
C. compactus	+							+			
C. difformis							+				
C. digitatus			+	+			+	+	+	+	
C. distans							+				
C. elatus							+	+			
C. grandis	+						+				
C. halpan							+	+		+	
C. imbricatus	+						+				
C. iria				+							
C. javanicus			+							+	
C. malaccensis			+				+	+			
C. odoratus							+				
C. pilosus							+				
C. platystylis			+								
C. polystachyos						+	+	+		+	

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
C. procerus										+	
C. ramosii							+				
C. rotundus				+							
C. stoloniferus											+
C. tegetiformis							+				
Eleocharis atropurpurea			+							+	
E. dulcis	+			+	+	+	+	+	+	+	
E ochrostachys					+	+	+			+	
E. retroflexa										+	
E. spiralis							+	+			
Fimbristylis acuminata							+	+			
F. bisumbellata							+				
F. dichotoma							+				
F. eragrostis							+				
F. ferruginea											+
F. griffithii							+				
F. littoralis									+		
F. miliacea		+				+	+				
F. nutans							+				
F. pauciflora							+				
F. polytrichoides											
F. sieberiana			+		+						
Fuirena umbellata							+	+		+	
Lepironia articulata						+	+	+		+	
Machaerina falcata			+				+				
Rhynchospora barbatum							+				
R. rubra							+				
Scirpus articulatus				+		+	+	+			
S. grossus	+		+	+		+	+	+	+	+	
S. juncoides							+				
S. littoralis							+				
S. mucronatus						+	+	+			
Scleria levis							+				
S. oblata							+	+			
S. poaeformis	+		+			+	+	+	+		
S. sumatrensis			+				+	+	+		
Dilleniaceae											
Tetracera scandens							+				
Dioscoreaceae											
Dioscorea cambodiana							+				
D. glabra								+			
Dipterocarpaceae											
Hopea odorata									+		
Elaeocarpaceae											
Elaeocarpus hygrophilus							+	+	+	+	
Elatinaceae											
Bergia ammanioides									+	+	

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Ericaulonaceae											
Eriocaulon setaceum										+	
E. sexangulare										+	
Euphorbiaceae											
Antidesma ghaesembilla							+				
Breynia vitis-idaea							+				
Bridelia stipularis								+	+		
Croton thorelii							+				
Excoecaria agallocha		+					+				
Glochidion littorale							+	+			
Hymenocardia wallichii							+				
Mallotus anisopodus				+	+						
Phyllanthus reticulata								+		+	
P. urinaria							+	+			
Securinega virosa							+	+			
Fabaceae											
Aeschynomene americana										+	
A. aspera										+	
A. indica										+	
Canavalia cathartica							+				
Cassia grandis									+	+	
Centrosema pubescens			+							+	
Dalbergia candenatensis			+				+				
Derris marginata	+						+				
D. trifolia			+				+				
Desmodium triflorum							+				
Intsia bijuga											+
Mimosa pigra				+	+		+		+	+	
M. pudica	+			+	+						
Neptunia oleacera										+	
Sesbania cannabina									+		
S. sesban			+							+	
Sindora siamensis							+				
Smithia sensitiva							+				
Tamarindus indica				+	+			+			
Vigna luteola			+		+		+	+			
V. marina							+				
Flacourtiaceae											
Scolopia macrophylla							+			+	
Flagellariaceae											
Flagellaria indica	+		+				+	+	+	+	
Hydrocharitaceae											
Blyxa aubertii										+	
Hydrilla verticillata							+	+		+	
Nechamandra alternifolia								+		+	
Ottelia alismoides										+	
Hydrophyllaceae											
Hydrolea zeylanica										+	

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Lamiaceae											
Hyptis brevipes							+				
Lauraceae											
Cassytha filiformis				+	+		+	+			
Lecythidaceae											
Barringtonia acutangula							+	+	+		
Leeaceae											
Leea rubra							+				
Lemnaceae											
Lemna aequinoxialis			+				+	+	+	+	
L. tenera			+					+			
Spirodela polyrrhiza	+		+	+	+			+		+	
Wolffia globosa			+							+	
Lentibulariaceae											
Utricularia aurea							+	+		+	
U. gibba							+	+		+	
U. punctata							+	+		+	
U. stellaris										+	
Loganiaceae											
Fagraea crenulata			+						+		
Loranthaceae											
Dendrophtoe pentandra		+					+	+		+	
Viscum articulatum										+	
V. ovalifolium											+
Lythraceae											
Lagestroemia speciosa										+	
Rotala indica										+	
R. wallichii										+	
Malvaceae											
Abelmoschatus mostachus	+							+			
Hibiscus tiliaceus							+	+			
Sida javensis									+	+	
Thespesia populnea		+					+				
Urena lobata							+				
Marantaceae											
Schumannianthus dichotomus									+	+	
Marsileaceae											
Marsilea quadrifolia							+	+		+	
Melastomataceae											
Melastoma affine	+		+			+	+	+	+		
Osbeckia chinensis							+				
O. cochinchinensis								+	+	+	
Meliaceae											
Aglaia cucullata									+		
Xylocarpus granatum		+									
X. mekongensis											+
X. moluccensis											+

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Menyanthaceae											
Nymphoides hydrophyllaceum										+	
N. indica				+			+	+	+	+	
Moraceae											
Ficus microcarpa							+	+	+	+	
F. superba									+		
Myriophyllaceae											
Myriophyllum dicoccum										+	
Myristicaceae											
Horsfieldia irya								+			
Myrsinaceae											
Aegiceras corniculatum											+
A. floridum											+
Myrtaceae											
Melaleuca cajuputi	+		+	+	+	+	+	+	+	+	
Syzygium cinereum							+		+		
S. cumini							+	+		+	
S. lineatum									+		
Naiadaceae											
Naias indica								+		+	
Nepenthaceae											
Nepenthes mirabilis								+			
Nympheaceae											
Nymphaea lotus						+	+	+	+	+	
N. nouchali	+		+	+	+	+	+	+	+	+	
N. pubescens	+		+	+	+	+			+		
N. tetragona	+			+		+	+	+	+		
Onagraceae											
Ludwidgia adscendens	+		+	+			+	+	+	+	
L. hyssopifolia							+	+		+	
Pandanaceae											
Pandanus kaida							+	+	+		
P. tectorius											+
Parkeriaceae											
Ceratopteris thalictroides								+		+	
Passifloraceae											
Passiflora foetida	+		+				+	+	+		
Philydraceae											
Philydrum lanuginosum			+				+	+		+	
Piperaceae											
Peperomia pellucida	+	+	+	+	+				+	+	
Poaceae											
Apluda mutica							+				
Arundinella setosa							+				
Brachiaria eruciformis							+	+			
B. mutica	+						+	+		+	
B. ramosa										+	
Chloris barbata							+				

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Coix aquatica	+						+			+	
Cynodon dactylon	+	+		+			+	+		+	
Dactyloctenium aegyptiacum							+			+	
Digitaria abludens							+				
D. petelotii							+	+			
D. setigera							+	+			
Echinochloa colonum							+	+			
E. crus-galli							+	+		+	
E. crus-pavonis							+				
E. stagnina	+						+	+	+		
Eleusine indica				+			+	+		+	
Eragrostis atrovirens							+			+	
E. malayana							+				
E. tremula							+				
Erianthus arundinaceus										+	
Eriochloa polystachya			+							+	
E. procera							+	+			
Hemarthria longiflora							+	+			
H. protensa							+				
Hygroryza aristata								+		+	
Hymenachne acutigluma	+		+	+	+		+	+	+	+	
Imperata cylindrica			+				+	+			
Isachne miliacea							+	+			
Ischaemum barbatum							+				
I. indicum								+		+	
I. rugosum					+		+	+		+	
I. tenuifolium							+				
Leersia hexandrra							+	+		+	
Leptochloa chinensis							+	+			
L. filiormis							+	+			
Mnesithea laevis							+				
Oryza rufipogon							+		+	+	
Panicum antidotale	+										
P. repens					+		+	+	+	+	
Paspalidium flavidum										+	
P. geminatum							+	+			
P. punctatum									+		
Paspalum commersonii							+				
P. conjugatum							+	+		+	
P. longifolium							+				
P. orbiculare							+				
P. paspalodes					+		+				
P. scrobiculatum							+				
P. vaginatum							+	+			
Phragmites vallatoria	+		+				+	+	+	+	
Pseudoraphis brunoniana						+	+			+	
Saccharum officinarum	+		+								
S. spontaneum	+				+		+	+			

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Sacciolepis aurita							+				
S. indica							+			+	
S. interrupta							+	+			
S. polymorpha							+				
Schizostachyum brachycladum			+								
Scleroschya milroyi							+	+		+	
Setaria pallide-fusca							+				
S. viridis							+				
Sorghum propinquum										+	
Sporobolus virginicus							+	+			
Vossia cuspidata										+	
Zoysia matrella							+				
Polygonaceae											
Polygonum barbatum							+	+			
P. hydropiper									+		
P. tomentosum							+	+	+	+	
Pontederiaceae											
Eichhornia crassipes	+						+	+		+	
Monochoria elata							+				
M. hastata							+	+		+	
M. ovata										+	
M. vaginalis							+	+		+	
Portulacaceae											
Portulaca oleacera	+		+	+	+			+			
Rhamnaceae											
Zizyphus oenoplia							+				
Rhizophoraceae											
Bruguiera cylindrica											+
B. gymnorrhiza		+					+				
B. parviflora		+									
B. sexangula		+					+				
Carallia brachiata							+				
Ceriops decandra											+
C. tagal		+									
Kandelia candel		+									
Rhizophora apiculata		+					+				
R. mucronata							+				
R. stylosa											+
Rubiaceae											
Gardenia lucida							+				
Guettarda speciosa											+
Hedyotis herbacea							+				
H. heynii										+	
Mitragyna speciosa										+	
Morinda persicaefolia							+			+	
M. tomentosa							+				
Nauclea orientalis							+			+	
Neolamarckia cadamba									+		

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Paederia consimilis							+	+			
Psychotria serpens								+			
Scyphiphora hydrophyllacea											+
Rutaceae											
Acronychia pedunculata								+			
Euodia lepta			+					+			
Salvadoraceae											
Azima sarmentosa											+
Salviniceae											
Salvinia cucullata	+		+				+	+	+	+	
Sapindaceae											
Allophyllus cochinchinensis							+				
A. glaber							+				
Schizeaceae											
Lygodium flexuosum								+	+		
L. japonicum							+				
L. scandens							+	+			
Scrophulariaceae											
Bacopa monnieri							+				
Centranthera cochinchinensis							+				
Limnophila heterophylla			+						+	+	
Lindernia antipoda										+	
L. crustacea							+	+			
L. micrantha										+	
Lymnophila indica										+	
Scoparia dulcis							+				
Solanaceae											
Physalis angulata							+	+			
Solanum americanum								+			
Sonneratiaceae											
Sonneratia alba							+				
S. caseolaris							+				
S. griffithii							+				
S. ovata											+
Sphaenocleaceae											
Sphaenoclea zeylanicum							+			+	
Sterculiaceae											
Helicteres hirsuta							+				
Heritiera littoralis							+				
Kleinhofia hospita											+
Styracaceae											
Styrax agrestis											+
Thelypteridaceae											
Cyclosorus gongylodes			+				+	+	+	+	
Trapaceae											
Trapa bicornis										+	
Typhaceae											
Typha angustifolia							+	+			

Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Ulmaceae											
Trema orientalis								+			
Verbenaceae											
Avicennia alba		+					+				
A. marina		+					+				
A. officinalis											+
Clerodendrum inerme							+	+			
Gmelina asiatica							+			+	
Stachytarpheta jamaicensis							+				
Vitaceae											
Cayratia geniculata							+				
C. trifolia	+		+				+	+	+		
Cissus modeccoides							+	+			
Xyridaceae											
Xyris indica				+		+	+	+		+	
X. pauciflora							+				
Zingiberaceae											
Costus speciosus	+										

Sources:
BirdLife/IEBR surveys, February–May and July–August 1999.
Tram Chim National Park Management Board list of plant species of Tram Chim National Park.
Anon. (1998)
Tran Triet *et al.* (in press).
Safford *et al.* (in press).

Key: 1 = Lung Ngoc Hoang; 2 = Dat Mui, Bai Boi; 3 = Vo Doi; 4 = Tra Su; 5 = Tinh Doi; 6 = Kien Luong; 7 = Ha Tien; 8 = U Minh Thuong; 9 = Lang Sen; 10 = Tram Chim; 11 = elsewhere in the Mekong Delta.

Appendix 2b: Cultivated plant species recorded in the Mekong Delta

Amaranthaceae
Celosia argentea
Amarylliadaceae
Allium ascalonicum
A. chinense
Anacardiaceae
Anacardium occidentale
Mangifera indica
Spondias cythera
Annonaceae
Annona muricata
A. reticulata
Apiaceae
Eryngium foetidum
Arecaceae
Boassus flabellifer
Cocos nucifera
Basellaceae
Basella rubra
Bombacaceae
Ceiba pentandra
Brassicaceae
Brassica juncea
Raphanus sativus
Bromeliaceae
Ananas comosus
Caricaceae
Carica papaya
Cassuarinaceae
Cassuarina equisetifolia
Convolvulaceae
Ipomoea batatas
Cucurbitaceae
Benincasia hispida
Citrullus lanatus
Cucumis sativus
Cucurbita moschatta
Lagenaria sicearia
Momordica charantia
Elaeocarpaceae
Muntingia calabura
Euphorbiaceae
Manihot esculenta
Phyllanthus acidus
Ricinus communis
Sauropus androgynus
Fabaceae
Acacia auriculaeformis
A. magnum
Arachis hypogea
Delonix regia
Malvaceae
Abelmoschatus esculentus
Moraceae
Artocapus heterophyllus
Musaceae
Musa paradisiaca
Myrtaceae
Eucalyptus camaldulensis
Pzidium gujava
Nelumbonaceae
Nelumbo nucifera
Nympheaceae
Nymphaea rubra
Pedaliaceae
Sesamum orientale
Piperaceae
Piper belte
P. lolot
Poaceae
Bambusa tulda
B. variabilis
B. vulgaris
Dendroccalamus asper
Oryza sativa
Polygonaceae
Polygonum odoratum
Rutaceae
Citrus aurantiifolia
C. grandis
C. sinensis
Sapotaceae
Chrysophyllum cainito
Manilkara achras
Pouteria zapota
Sauruaceae
Houttuynia cordata
Solanaceae
Capsicum frutescens
Lycopersicon esculentum
Nicotiana tobacum
Solanum melongena
S. undatum
Sterculiaceae
Firmania simplex
Tiliaceae
Corchorus capsularis
Verbenaceae
Premna serratifolia

Appendix 3: Bird species recorded in the Mekong Delta

Species recorded during fieldwork, February–May and July–August 1999.

Order, Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Galliformes											
Phasianidae											
Francolinus pintadeanus							+				
Anseriformes											
Dendrocygnidae											
Dendrocygna javanica	+			+	+	+	+	+	+	+	
Anatidae											
Sarkidiornis melanotos						+					
Nettapus coromandelianus				+		+				+	
Anas poecilorhyncha	+			+	+	+	+	+	+	+	
A. querquedula						+					
Turniciformes											
Turnicidae											
Turnix sp.										+	
Piciformes											
Picidae											
Dendrocopus canicapillus								+			
Picus vittatus			+								
Chrysocolaptes lucidus		+	+								
Gen. sp.				+							
Megalaimidae											
Megalaima haemacephala											+
Coraciiformes											
Coraciidae											
Coracias benghalensis							+	+			
Eurystomus orientalis											+
Alcedinidae											
Alcedo atthis	+	+	+	+	+	+	+	+		+	
Halcyonidae											
Halcyon capensis		+	+	+	+	+	+	+			
H. smyrnensis	+			+	+	+	+	+		+	
H. pileata	+	+	+		+	+					
Todiramphus chloris	+	+	+				+		+		
Cerylidae											
Ceryle rudis										+	
Meropidae											
Merops orientalis							+		+	+	
M. philippinus	+			+	+	+	+	+	+	+	
M. leschenaulti											+
Cuculiformes											
Cuculidae											
Clamator coromandus											+
Cuculus sp.						+	+				
Cacomantis merulinus	+	+	+	+	+	+	+	+		+	

Order, Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Eudynamys scolopacea	+			+				+		+	
Phaenicophaeus tristis	+	+	+	+				+	+	+	
Centropodidae											
Centropus sinensis	+	+	+	+	+	+		+	+	+	
C. bengalensis	+			+	+	+	+	+	+	+	
Psittaciformes											
Psittacidae											
Psittacula sp.								+			
Apodiformes											
Apodidae											
Collocalia sp.				+				+			
Hirundapus caudacutus/cochinchinensis		+									
Cypsiurus balasiensis					+	+	+			+	
Apus pacificus								+			
A. affinis						+	+				+
Strigiformes											
Tytonidae											
Tyto alba					+						
T. capensis										+	
Strigidae											
Otus bakkamoena											+
Caprimulgidae											
Caprimulgus macrurus			+	+					+	+	
Columbiformes											
Columbidae											
Streptopelia chinensis	+			+	+	+	+	+	+	+	
S. tranquebarica				+	+	+	+	+	+	+	
Chalcophaps indica											+
Treron vernans	+			+			+	+	+	+	
Gruiformes											
Otididae											
Houbaropsis bengalensis										+	
Gruidae											
Grus antigone							+			+	
Rallidae											
Gallirallus striatus			+								
Amaurornis phoenicurus		+	+	+	+			+	+		
Porzana fusca				+	+	+		+	+	+	
Gallicrex cinerea	+			+	+	+	+	+	+	+	
Porphyrio porphyrio	+			+	+	+		+		+	
Gallinula chloropus				+	+	+		+	+	+	
Ciconiiformes											
Scolopacidae											
Gallinago stenura							+	+			
Limosa limosa		+	+				+				
L. lapponica		+									
Numenius phaeopus		+	+								
N. arquata		+	+								

Order, Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
N. madagascariensis		+	+								
Tringa totanus		+	+				+				
T. stagnatilis		+	+								
T. nebularia		+	+				+	+			
T. ochropus											+
T. glareola			+		+		+			+	
Xenus cinereus		+									
Actitis hypoleucos		+	+				+	+		+	
Heteroscelus brevipes			+								
Arenaria interpres			+								
Limnodromus semipalmatus		+	+								
Calidris ferruginea			+								
Rostratulidae											
Rostratula benghalensis										+	
Jacanidae											
Hydrophasianus chirurgus						+				+	
Metopidius indicus	+			+				+		+	
Charadriidae											
Himantopus himantopus			+		+		+	+		+	
Pluvialis fulva		+	+								
P. squatarola		+	+								
Charadrius mongolus			+								
C. leschenaultii			+								
Vanellus cinereus			+							+	
V. indicus							+		+	+	
Glareolidae											
Glareola maldivarum				+	+	+	+	+	+	+	
Laridae											
Larus brunnicephalus		+	+								
Gelochelidon nilotica			+								
Sterna caspia		+	+								
S. bergii											+
S. sumatrana											+
S. hirundo		+					+				
S. albifrons											+
Chlidonias hybridus		+	+								
C. leucopterus								+			
Accipitridae											
Pandion haliaetus		+	+								
Elanus caeruleus	+		+	+	+	+	+	+	+	+	
Milvus migrans				+							
Haliastur indus		+	+				+				
Haliaeetus leucogaster											+
Spilornis cheela				+				+			
Circus aeruginosus				+	+	+				+	
Accipiter badius										+	
A. gularis						+					
A. sp.				+		+		+			

Order, Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Butastur indicus				+							
Spizaetus cirrhatus					+			+			+
Falconidae											
Falco peregrinus			+				+				
Podicipedidae											
Tachybaptus ruficollis				+	+	+			+	+	
Anhingidae											
Anhinga melanogaster					+	+				+	
Phalacrocoracidae											
Phalacrocorax niger	+	+	+	+	+	+	+	+	+	+	
P. fuscicollis					+	+				+	
Ardeidae											
Egretta garzetta		+	+	+	+	+	+	+	+	+	
E. eulophotes		+	+								
E. sacra											+
Ardea cinerea		+	+	+	+	+	+	+		+	
A. purpurea	+	+		+	+	+	+	+	+	+	
Casmerodius albus	+	+	+	+	+		+	+		+	
Mesophoyx intermedia										+	
Bubulcus ibis				+	+	+	+	+	+	+	
Ardeola bacchus	+	+		+	+	+	+	+	+	+	
A. speciosa		+	+		+		+	+			
A. sp.	+	+	+								
Butorides striatus		+	+	+	+		+		+	+	
Nycticorax nycticorax	+			+	+	+	+	+		+	
Ixobrychus sinensis	+	+	+	+	+	+	+	+	+	+	
I. cinnamomeus	+			+	+	+	+	+	+	+	
Dupetor flavicollis	+			+	+	+		+	+	+	
Threskiornithidae											
Plegadis falcinellus								+			
Threskiornis melanocephalus			+					+			
Pseudibis davisoni							+				
Pelecanidae											
Pelecanus philippensis			+				+				
Ciconiidae											
Mycteria leucocephala		+	+		+		+				
Anastomus oscitans								+			
Ciconia episcopus						+	+				
Leptoptilos javanicus								+			
Fregatidae											
Fregata sp.								+			
Passeriformes											
Pardalotidae											
Gerygone sulphurea	+	+	+	+	+	+	+	+	+	+	
Laniidae											
Lanius cristatus	+			+		+	+	+	+	+	
Corvidae											
Crypsirina temia	+	+	+	+		+	+	+	+	+	

Order, Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Corvus macrorhynchos				+							+
Coracina polioptera				+						+	
Pericrocotus cinnamomeus											+
P. flammeus				+				+			
Rhipidura javanica	+	+	+	+	+	+		+	+	+	
Dicrurus macrocercus	+	+		+	+	+	+	+	+	+	
D. leucophaeus				+							
D. paradiseus				+				+			
Aegithina tiphia	+	+	+	+		+	+	+	+	+	
Muscicapidae											
Copsychus saularis	+	+	+	+	+	+	+	+	+	+	
C. malabaricus											+
Saxicola torquata							+				
S. caprata							+		+	+	
Sturnidae											
Sturnus malabaricus					+	+		+			
S. sinensis											+
S. nigricollis				+			+	+			
S. burmannicus								+	+		
Acridotheres tristis						+	+	+			
A. cinereus		+	+				+				
Paridae											
Parus major											+
Hirundinidae											
Riparia riparia				+	+			+	+	+	
Hirundo rustica	+	+	+	+	+	+	+	+	+	+	
H. daurica					+	+	+	+	+		
Pycnonotidae											
Pycnonotus goiavier	+			+		+	+	+	+	+	
P. blanfordi	+			+		+	+	+	+	+	
Cisticolidae											
Cisticola juncidis				+	+	+	+	+	+	+	
Prinia rufescens											+
P. flaviventris	+			+				+	+	+	
P. inornata	+			+	+	+	+	+	+	+	
Zosteropidae											
Zosterops palpebrosus	+	+	+	+	+	+			+	+	
Sylviidae											
Locustella lanceolata	+							+		+	
L. certhiola	+			+	+	+		+		+	
Acrocephalus bistrigiceps	+			+	+	+	+	+	+	+	
A. orientalis	+	+	+	+	+	+	+	+	+	+	
A. aedon											+
Orthotomus sutorius			+	+	+	+	+	+	+	+	
O. atrogularis				+			+		+		
O. ruficeps		+	+		+						
Phylloscopus fuscatus			+								
P. tenellipes					+						

Order, Family, Genus and Species	Site										
	1	2	3	4	5	6	7	8	9	10	11
Megalurus palustris				+	+	+	+	+	+	+	
Pellorneum ruficeps				+							
Macronous gularis	+			+				+	+	+	
Timalia pileata	+			+				+			
Alaudidae											
Mirafra assamica							+				
Alauda gulgula							+			+	
Nectariniidae											
Dicaeum cruentatum	+			+			+	+	+		
Anthreptes malacensis	+								+		
Nectarinia sperata				+		+		+			
N. jugularis	+	+		+	+	+	+	+	+	+	
Passeridae											
Passer flaveolus	+					+	+	+		+	
P. montanus				+	+	+	+	+	+	+	
Motacilla flava								+	+		
M. cinerea			+								
Anthus richardi			+								
A. rufulus					+		+		+	+	
Ploceus manyar					+					+	
P. philippinus									+	+	
P. hypoxanthus					+					+	
P. sp.				+				+			
Lonchura striata	+			+				+		+	
L. punctulata				+	+		+	+	+		
L. malacca				+	+	+	+	+		+	
Fringillidae											
Emberiza aureola								+			

Key: 1 = Lung Ngoc Hoang, 2 = Bai Boi, 3 = Dat Mui, 4 = Vo Doi, 5 = Tra Su, 6 = Tinh Doi, 7 = Ha Tien, 8 = U Minh Thuong, 9 = Lang Sen, 10 = Tram Chim, 11 = elsewhere in the Mekong Delta.