AN ABSTRACT OF THE DISSERTATION OF

Ronasit Maneesai for the degree of Doctor of Philosophy in Forest Science presented on August 12, 2003.
Title: Effectiveness of Protected Area Management in Thailand.

Abstract approved: Signature redacted for privacy.
John P. Hayes

The main objectives of this study are to identify the nature of threats to protected areas and assess the effectiveness of protected area systems and management in Thailand, and to evaluate the use of conservation biology concepts in protected area management. The results from a survey of the heads of Thai national parks and wildlife sanctuaries, interviews and discussions with experts and the staff of the Thai Royal Forest Department (RFD), site visits, and a review of in-house documents of the RFD suggest that overall threats to protected areas throughout the country are illegal hunting, illegal logging, land encroachment, extraction of non-timber forest products, and pressure from people living around the protected units. Similar patterns of threats were also found when data were evaluated by region and by protected category. Overall level of impact from the threats are high in all protected areas, whereas spatial and temporal scales of impacts are low, resistance of protected areas to threats is high, and resilience of areas is low. Overall effectiveness of protected areas is rated at a moderate level; effectiveness of the system is high but effectiveness of management is moderate. The study also revealed gaps in the evaluation of effectiveness of the systems and

management, related to reserve design, selection, prioritization, evaluation, policy, management, and public involvement. Recommendations to improve protected area system and management in Thailand are provided. Guidelines to apply conservation biology concepts in protected area management are also suggested. Research direction should focus on conflict resolution, building the capacity of protected area systems and management, restoration in deforested ecosystem, and more efficient use of timber and non-timber forest products.

Effectiveness of Protected Area Management in Thailand

by

Ronasit Maneesai

A DISSERTATION

Submitted to
Oregon State University

In partial fulfillment of
the requirement for the
degree of

Doctor of Philosophy

Presented August 12, 2003
Commencement June 2004

Doctor of Philosophy Dissertation of Ronasit Maneesai
presented on August 12, 2003.

APPROVED:

Signature redacted for privacy.

Major Professor, representing Forest Science

Signature redacted for privacy.

Head of Department of Forest Science

Signature redacted for privacy.

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Signature redacted for privacy.

Ronasit Maneesai, Author

ACKNOWLEDGEMENTS

I am deeply indebted to the Thai Government for supporting me financially throughout my study. I would like to extend thanks to the Royal Forest Department and the Ministry of Agriculture and Cooperatives (MOAC) for allowing me the time for the study.

I would like to thank Dr. Plodprasop Suraswadi, the Permanent Secretary of the Ministry of Natural Resources and Environment (MONRE) and Mr. Suvat Singhapant, the Deputy Permanent Secretary of the MONRE, for their support and discussions. Thanks to M.R. Bhadharajaya Rajani, the Deputy Director General of the RFD, for his great support; Mr. Apiwat Sretarugsa and Dr. Sawat Dulyapach, both Deputy Director Generals of the Park, Wildlife and Plant Conservation Department (PWPCD), MONRE, for their support and valuable time in discussions.

I would like to thank the Dr. Sanga Sabahira Fellowship and the Dilworth Memorial Award for providing for me financially to conduct the research in Thailand. Special thanks to the committee of the Dr. Sanga Sabahira Fellowship for providing me with an additional living allowance. I am indebted to Dr. Bart Thielges, Associate Dean of College of the Forestry and Interim Dean of International Program at Oregon State University (OSU) for approving additional funding for my study. Thanks also to Valerie Rosenberg and Pam Powell for their encouragement and facilitation in seeking financial support. Thanks to the

Department of Forest Science and the College of Forestry (COF) for providing me space and equipment throughout my study.

Thanks to the following professors who serve as my committee: Dr. John P. Hayes (chair), Dr. W. Daniel Edge, Dr. Steven R. Radosevich, and Dr. Reed F. Noss. Special thanks to Dr. John P. Hayes for his supervision and logistical support, in particular for the extensive access to his personal library. Thanks to the committee for their flexibility on my program and their challenges to me to think beyond the boundary of the research topic. I would like to thank my graduate representative Dr. R. Bruce Rettig for his support on my project. Special thanks to Dr. Gay A. Bradshaw for her invaluable time in the discussions that helped shape my vision of natural resources management in a changing world.

I would like to express my great and sincere thanks to the following professors: Dr. George W. Brown, Dean Emeritus, COF, who always encouraged and generously supported me throughout my study; Dr. Logan A. Norris, Professor Emeritus and former Head of Forest Science Department, for his support and invaluable advice; Dr. Joe B. Zaerr, Professor Emeritus, for his guidance in improving my writing skills and teaching me about problem solving in natural resource management as well as how to prepare for a preliminary examination; Dr. Richard H. Waring, Professor Emeritus, for his great discussion and encouragement; Dr. James R. Boyle, Professor Emeritus, for his guidance to study in forest ecology; Dr. David A. Perry, Professor Emeritus, for his great discussion throughout his ecosystem management course; Dr. Kermit Cromack, Jr., Professor, for introducing me to the underground world and teaching me about forest fires; and Dr. George H. Stankey, Senior Researcher, Pacific Northwest Research Station, for his insightful discussion on protected area management and his supporting documents about park management as well as his permission for me to access his personal library.

I am indebted to Professor Surachet Chettamart, a faculty member at Conservation Department and Associate Dean of Faculty of Forestry, Kasetsart University (KU), for his generosity in reviewing my questionnaire, providing me a number of opportunities for the discussions, and supplying me documents related to protected area management in Thailand. Thanks to Mr. Seri Vejaboosakorn, a senior forester and faculty member from Conservation Department, for his generous and thoughtful discussion. Special thanks to Dr. Lert Chuntanaparb, whose insight and intellect provide the foundation much of my work. I am greatly indebted to Mr. Niwat Jatikanond for his generous support and invaluable advice. His constant encouragement inspired me to accomplish this project. Thanks to Mr. Chanchai Ngamcharoen and Mr. Preecha Ongprasert from Community Forestry Division, RFD, for their in-depth discussion and supporting information. Also, thanks to Mr. Krishna Brikshavana, Secretary of the RFD and Miss Aurawan Panyapornvittaya for their generosity in providing cabinet resolution documents and significant insight discussions on conflict resolution in protected area management in Thailand.

I would like to express my appreciation as well as special thanks to the following faculty members from Faculty of Forestry, KU, who provided information or great insight in discussions: Mr. Kobsak Wanthongchai, Department of Silviculture; Dr. Somwang Khantayanuwong, Department of Forest Products; Dr. Kankhajane Chuchip, Dr. Wuthipol Hoamuangkaew and Dr. Sompetch Mungkorndin, Department of Forest Management; Dr. Yongyut Trisurat and Professor Decha Wiwatwitaya, Department of Forest Biology; and Dr. Dachanee Emphandhu and Dr. Noppawan Tanakanjana, Department of Conservation.

I would like to express my sincere thanks to Director Thaweechai Senisrisant and Senior Forester Sophon Nakaphan for their generosity in providing space in an office, equipment, and supporting staff during my data collection. Special thanks to the Department of Forest Management, KU, for facilitating the questionnaire process. I would like to thank Dr. Saovakorn Sudsawasd, Department of Sociology, KU, for her comments and for reviewing questionnaires, and special thank to Professor Dwaine E. Plaza, Department of Sociology, OSU, for his help in reviewing the first draft of my questionnaire.

I would like to thank Dr. Anak Pattanavibool of the Western Complex Office, RFD, for his supporting documents and generous and thoughtful advice, as well as for helping with site visit; Dr. Theerapat Prayurasiddhi of the Forestry Biological Diversity Secretary Office for his support and constructive advice as well as providing me documents and information in protected area management; and Mr. Chumpon Chaichana, an assistant superintendent from the Wildlife

Conservation Division, for helping, supporting, accommodating, and facilitating me during the site visit.

I warmly thank many friends and colleagues in the RFD who provided me significant insight information and contributed material about protected area management in Thailand: Mr. Kowit Suntajit and Miss Patcharaporn Utayan from Wildlife Conservation Division; Mr. Pongboon Pongtong, Mr. Dumri Jitjaichum, Miss Chantanaphorn Ampholchan, and Miss Peeranuch Dulkul from National Park Division; Mrs. Tippawan Sethapun from Marine National Park Division; and Mr. Anusorn Rungsipanich from Geo-Informatic Division. Special thanks to Mr. Narongrit Sukprakarn, who was always seeking my requested information; Mr. Anirut Thanomwatana from the RFD Information Office, who helped me generously find out information in the RFD; and Mr. Vissanu Domrongsutsiri and his staff for helping me in my research.

I am very grateful for the tremendous assistance from many of my friends from Forester` 50. Special thanks to Dr. Wijarn Meepol, the Head of Mangrove Research Station; Mr. Apisit Pidthong, a superintendent at Khao Soi Dao Wildlife Sanctuary; Pisit Piyasomboon, park manager from National Park Division; and Mr. Charat Chuayna, a research forester from the RFD.

Special thanks to Mrs. Piyathip Eawpanich, Thailand Programme Officer, IUCN Asia Regional Office, for her thoughtful advice in conducting research in protected area management; Mr. Sarawuth Naramngam, Pollution Control Department, MONRE, for helping find information; and Miss Rossana

Sawatdiparb, National Research Council of Thailand (NRCT) for her efforts to support me information from the NRCT library.

Thanks to the heads of protected areas and all participants who generously contribute their time and expertise in response to my inquiries. Without their help, this project could not have been accomplished. I would like to thank the many people who have shape my thought through discussion and disagreement. Thanks also for the help from the people I know but are too numerous to mention.

Thanks to Manuel Huso, a statistician at the Department of Forest Science, OSU, for her consultations. Special thanks to Jason Schmurr, a graduate student at OSU, for his timely editing of the first draft of the manuscript. Thanks to my host family, Stewart and Dennis Branam, for their hospitality throughout my stay with them.

Finally, I thank my mom for her great support and encouragement for my education.

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

ANZECC = Australian and New Zealand Environmental and Conservation Council

ARCBC = ASEAN Regional Centre for Biodiversity Conservation

ASEAN = Association of South- East Asian Nations

BLM = Bureau of Land Management

CIDA = Canadian International Development Agency

CFAN = CIDA Forestry Advisors Network

CIFOR = Center for International Forestry Research

CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora

CNPPA = Commission on National Parks and Protected Areas (prior to WCPA)

COF = College of Forestry

CSIRO = Commonwealth Scientific and Industrial Research Organization

EIA = Environmental Impact Assessment

FAO = Food and Agricultural Organization of the United Nations

FINNIDA = Finnish International Development Agency

FRC = Forestry Research Center

GIS = Geographic Information System

ICDP = Integrated Conservation and Development Project

ICM= Integrated Coastal Management

ITTO = International Tropical Timber Organization

IUCN = International Union for Conservation of Nature and Natural Resources

IUFRO = International Union of Forestry Research Organization

KU = Kasetsart University

LAC = Limits of Acceptable Change

MAB = UNESCO's Program on Man and the Biosphere

MAR = Minimum Area Requirement

MIDAS = Mekhong International Development Associations

MNPD = Marine National Park Division

MOAC = Ministry of Agriculture and Cooperatives

MONRE = Ministry of Natural Resources and Environment

MVP = Minimum Viable Population

NESDB = National Economic and Social Development Board

NESDP = National Economic and Social Development Plan

NGOs = Non-Governmental Organizations

NOAA = the United States National Oceanic and Atmospheric Administration

NOS = National Ocean Service

NP = National Park

NPS = National Park Service

NRCT = National Research Council of Thailand

OEPP = Office of Environmental Policy and Planning

OSU = Oregon State University

PA(s) = Protected Area (s)

PVA = Population Viability Analysis

PWPCD= Park, Wildlife and Plant Conservation Department

RAMSAR = RAMSAR Convention on Wetlands

RECOFTC = Regional Community Forestry Training Center

RFD = Royal Forest Department

ROS = Recreation of Opportunity Spectrum

SSC = Species Survival Commission

TFSMP = Thai Forestry Sector Master Plan

UNEP = United Nations Environment Programme

UNESCO = United Nations Educational, Scientific and Cultural Organization.

USDA = United States Department of Agriculture

VERP = Visitor Experience Resource Protection

VIM = Visitor Impact Management

WCMC = The World Conservation Monitoring Center

WCPA = World Commission on Protected Areas

WEFCOM = Western Forest Complex Ecosystem Management

WHC = World Heritage Convention

WS = Wildlife Sanctuary

WWF = World Wildlife Fund

DEDICATION

I dedicate this dissertation to the Thai people who love and protect nature, to conservationists, educators, and the staff of the Thai government who dedicate their lives to preserving precious natural resources in this country. I want to express my sincere appreciation the work of conservation biologists and foreigners who support and dedicate their work to the conservation of natural resources in Thailand.

Effectiveness of Protected Area Management in Thailand

Chapter 1

Introduction

1.1 Introduction

Protected areas have been widely used to conserve biodiversity throughout the world (IUCN 1998, Dudley and Stolton 1998, Dudley et al. 1999b, Stolton and Dudley 1999). As defined by the International Union for Conservation of Nature and Natural Resources (IUCN) at the Fourth World Congress of the Protected Areas and National Park in Caracas, a protected area is an area dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, that is managed through legal or other effective means (IUCN 1994, Sheppard 1998). At this time, protected areas cover approximately 9% of the total land area globally (Green and Paine 1998, 1999). Designed based on management objectives, protected areas have played a major role in protecting targeted species from extinction (Leader-Williams et al.1990, Wright 1996, Kramer et al. 1997, Brandon et al. 1998, Worboys et al. 2001). Despite successes in many parts of the world, protected areas are still confronted with direct and indirect pressures, mainly caused by human activities, such as, logging, hunting, and land encroachment (Carey et al. 2000). Most of these activities occur in developing countries where there is high population growth. Because of these pressures, protecting targeted areas is costly; knowing how well a protected area is performing is a crucial question for any country that has limited resources. Despite recent works to evaluate the effectiveness of protected areas (Pressey et al. 1996, Hocking and Twyford 1997, Sing 1999, Bruner et al. 2001b, Jepson et al. 2002, Pressey et al. 2002), many protected areas still need to be evaluated, because the numbers of areas have increased in direct proportion with human conflicts.

Thailand has successfully increased the number and total area of protected areas. Though the protected area system and management have been reviewed and assessed by MacKinnon and MacKinnon (1986), Kasetsart University (1987), MacKinnon (1997), and Wikramanayake et al. (2002), little is known about the effectiveness of protected area system and management. Previous research suggested that evaluation of effectiveness is necessary to manage protected areas in Thailand (MacKinnon 1997). The lack of evaluation sometimes misleads some people, both from the government and non-government organizations (NGOs), who are involved in natural resources management, into arguing that establishing protected areas causes conflicts in land use of the country. Moreover, how well the system performs is still questioned by the public. Politicians use this misunderstanding of protected areas as a political issue. Therefore, evaluation of the effectiveness of protected areas can play an important role in helping all parties involved in natural resources management to understand the efficiency of the system and management and to move toward more sustainable practices.

This thesis is the result of an attempt to gather opinions from the heads of protected areas (national parks and wildlife sanctuaries); senior staff, directors, and foresters of the RFD who have been working in protected areas over the last three decades; and experts who are working in universities. The purpose of this thesis is to identify threats and problems by reviewing past and current status of protected areas, to evaluate the effectiveness of protected area management, and to suggest options to improve Thailand's protected area system and management by applying conservation biology concepts to those problems. Though the study focused on Thailand, many of the findings and suggestions can also be applied to protected area management in other countries.

1.2 Justifications and Expected Accomplishments

Thailand has developed a protected area system in the last four decades. The number of protected areas slowly increased in the 1960's, substantially increased in the 1970's and 1980's, and gradually increased in the 1990's (RFD 1993b, 1999a). Thailand may have the most successful protected area system in Southeast Asia (Parr 1996, MacKinnon 1997, McQuistan 1999), but the effectiveness of Thailand's protected area system and management is still questionable. The increase in numbers and areas of protected reserves is a positive move of the country toward conservation. Yet, most protected areas in the country have been intensely confronted with threats caused by human activities, which are related to land-use conflicts occurring both inside and outside these areas.

While the number of units and area of protected areas has increased, total forested area in Thailand has decreased dramatically (RFD 1996a, 1999a, 2000, 2001b). In the last 30 years, Thailand experienced ongoing deforestation at rates exceeding 3 % a year and lost approximately 330,000 hectare of forest areas since 1960 (Durst et al. 2001). However, while the numbers and area of protected areas have increased, land-use conflicts have also increased. Also, population growth to 61 million in 1999 (RFD 1999a) combined with limited available land area has generated intense pressures on protected areas. Land-use conflicts have occurred in a wide range of groups in society, including poor and rich with government staff (e.g., staff of the RFD at Khao Yai National Park; Albers and Grinspoon 1997), highlanders with lowlanders in northern Thailand (McNeely and Dobias 1991, Fox et al. 1995, Tungittiplakorn and Bengtsson 1996), local people with loggers (McNeely and Dobias 1991), and shrimp farmers and NGOs with the government in mangrove and coastal area management (Flaherty and Karnjanakesorn 1995, Dierberg and Kiattisimkul 1996, Flaherty and Vandergeest 1998). By ignoring other major causes in land-use conflicts such as government policies (e.g., export policies, land reform projects) and unstable economics and politics, these problems have led the country into crisis in the last decade. More importantly, a lack of evaluation of protected areas also leads many groups of people to believe that creating protected areas is a major cause of creating land use conflicts in the country (Vandergeest 1996a, 1996b, 1999).

These misunderstandings and conflicts have caused the public to ask many questions in natural resource management concerning the equality and distribution of control of and access to natural resources, the efficiency of government sectors in protecting natural resources and the environment, and the effectiveness of the protected area system. A number of questions related to the effectiveness of protected areas have arisen: Is the protected area system effective (the adequacy and appropriate areas of individual and networks of protected areas)? Are current management techniques effective? What are the threats to protected areas both in the short and long term? How do these threats change and impact protected areas in each region, and how do protected areas respond to these changes? What is the effectiveness of current protected areas in protecting natural resources, and what are causes and consequences of this effectiveness? What are other options for protected areas management if present management is ineffective? What tools, approaches, and concepts (such as conservation biology) can be applied to protected area management? If so, how? What are major advantages and obstacles to implementing these concepts?

My findings of how well the system performs and how effectively management works are critical to developing strategies for preserving biodiversity in Thailand. My findings can be use to describe to the public the importance of protected areas. These also can be used to develop guidelines and frameworks for reserve design and selection, evaluation of management effectiveness, and monitoring projects, systematic protected areas, and conservation planning. Application of conservation biology concepts as developed in this thesis may help guide managers in future work to choose appropriate tools for closing existing gaps, such as the inadequacy of representativeness in protected areas. The applications can also be used to set up new protected units and expand as well as reclassify existing protected areas. Finally, my findings can be used to develop frameworks for long-term ecological monitoring projects both inside and outside protected areas. In short, these findings will benefit planners, managers, and all parties (e.g., other governmental departments, the public, local people), as well as international organizations and NGOs who are involved in natural resource management in Thailand and other part of Southeast Asia.

1.3 Objectives

The objectives of this study are to:

1) identify the nature of threats to protected areas both in short and long terms;

2) determine how these threats change and impact protected area management in each region in Thailand, and how these protected areas respond to these changes;

3) assess the effectiveness of the present protected area system in protecting natural resources in Thailand, and evaluate causes and consequences of protected area management; and

4) determine which concepts of conservation biology are pertinent to protected area systems and management, and how these concepts can be applied to protected area planning and management in Thailand.

Chapter 2

Application of Conservation Biology Concepts to Protected Area Management

2.1 Introduction

Conservation biology concepts have been developed and used as alternatives to conventional natural resources management for nearly three decades. The concepts originated from the emergence of conservation biology (Soulé 1985, Given 1993, Primack 1993, Noss and Cooperrider 1994, Noss et al. 1997, Soulé and Terborgh 1999), which is an applied discipline that integrates principles of natural and social science with the objective of achieving the long-term persistence of biodiversity (Dobson and Rodriguez 2001). The concepts are developed from the attempts of conservation biologists to find ways to understand and minimize human impacts, such as habitat alteration and overexploitation (Ehrlich and Kremen 2001).

Though much work has been done to develop the concepts of conservation biology (With 1997), less work has been done to test and apply the concepts (e.g., umbrella and indicator species) (Simberloff 1999). The applicability of some concepts is questionable (e.g., use of indicator groups as surrogates for overall species diversity) (Ehrlirch 1996). Planners and managers who apply these concepts on the ground have difficulty to understanding fundamental aspects of some conservation biology and how each concepts can be applied. In order to choose the right tools and approaches, managers need to understand the benefits and limitations of applying these concepts. Also, although conservation concepts have recently been developed, few have tried to integrate concepts and describe how to use them in different situations. This lack of integration causes planners and managers difficulty for application in choosing approaches and tools developed from conservation biology for application in the real world.

In this chapter, I integrate conservation biology concepts in analytical frameworks that can be used and applied in different situations (summarized in Appendix 1). My objectives are to describe briefly which conservation biology concepts are applicable to protected areas, their importance, and the advantages and disadvantages of applying these concepts to protected area management.

2.2 Current Concepts, Approaches, and Goals in Conservation Biology: A Brief Review

2.2.1 Hypotheses/Theories

(1) Island Biogeography. The theory of island biogeography is based on the hypothesis that the number of species on an island depends on its size and isolation and their influence on the balance between immigration and extinction. Immigration is more likely to occur in the islands closer to the mainland or a source population, while extinction is more likely to occur on the smaller islands

(MacArthur and Wilson 1967). Based on this notion, large islands located close to other islands or the mainland are more likely to have more species than smaller ones, or islands of similar size that are more isolated. The concept does not account for threat and hostility around an islands boundary, which commonly occur in cases where the island is not a true island but rather an isolated area surrounded by human-dominated land areas. When designing a reserve based on this theory, there are high uncertainties and potential threats that could harm even large islands, and large islands may not necessarily contain more species than smaller ones. Despite this debate, the concept is commonly used in the design of nature reserves (Diamond 1975, Diamond and May 1981, Spellerberg and Sawyer 1999). The concept can be applicable when setting up a new reserve and suggests that it is beneficial to establish large reserves, locate reserves close together, and maintain connectivity among reserves (Diamond and May 1981, Soulé and Terborgh 1999, Spellerberg and Sawyer 1999).

(2) Metapopulation. A metapopulation is a population of populations (Hanski 1991). These populations, or subpopulations, are distributed throughout habitat islands and have a colonization and extinction dynamic. Just as biogeography studies habitat islands, a metapopulation considers population islands (Pulliam and Johnson 2002). However, while island biogeography is a community–based model, metapopulation theory is concerned with the dynamics of population within a single species. The concept has been developed largely from small easily-

studied species (e.g., butterflies; Hanski 1991,1999b), and has not been applied extensively to many key species (such as carnivores) and protected area management. The concept is often challenging to apply because information on the distribution and dynamics of target species are not available in most areas that require long-term ecological studies (e.g., tropical forests). Other major limitations are the lack of information on subpopulations and suitable habitat outside reserves. In all cases, if information is available, the concept could be used in designing reserve networks in fragmented areas at the landscape scale for species exhibiting a metapopulation structure. For example, to provide habitats for subpopulations, all available subpopulations and habitats (whether they have the same or different ownerships) should be considered for some level of protection. Also, in managing a reserve, habitats outside the reserve may play important roles in providing habitats for subpopulations. Managers may need to consider the locations of remaining habitats and work with other land managers to conserve those habitats, or expand the reserve to include those areas.

(3) Source-Sink Population. A source habitat is an area where the number of surplus individuals from reproductive success is greater than local mortality (Pulliam 1988, Dias 1996, Pulliam and Johnson 2002). The source habitat could export individuals to a sink habitat, which is an area that has a local reproductive deficit because mortality is greater than the population reproductive rate. For sink habitats to persist, they must receive individuals through immigration from source

habitats (Pulliam and Johnson 2002). Many habitats could be sources at one time and sinks at another. Because the concept does not take into account threats or negative pressures from outside, both sources and sinks may be extirpated if external threats are greater than the resistance of the area (e.g., catastrophic events, land uses). Though the concept could be applicable for the design of terrestrial and marine reserves (e.g., Roberts 1998), it is rarely applied on the ground. With limited resources, we often try to conserve good habitats containing source populations and ignore degraded habitats. One advantage to use of this concept is that using focal or surrogate species in designing reserve may not cover other key species in the ecosystem; source and sink applications could be an alternative. By considering both source and sink populations, another advantage is that it can be applied with single species, groups of species, or representations at different spatial scales. In addition, application of this concept may lead to protection of important but marginal habitats (sinks) outside of existing reserves when designing reserve networks or expanding reserves. To guarantee the existence of individuals, improving and connecting source and sink habitats may also be an alternative.

(4) Range of Variability. Range of variability refers to the range and variation of ecological conditions in spatial and temporal scales (Swanson et al. 1993, Morgan et al. 1994, Landres et al. 1999). The concept has been developed from an attempt to manage or restore a damaged ecosystem to its previous status. The concept rarely takes into account issues in reserve design and management; no

reserve has been designed by using the range of variability as a major criterion. Instead, the concept may become usable after a reserve has been established. To understand range of variability, we need to understand the spatial and temporal dynamics of an area, which requires a sufficient database at different time scales. Uncontrollable and uncertain factors (e.g., global warming) can limit an interpretation and implementation based on previous conditions (Landres et al. 1999), and make it more difficult to manage protected areas within a range of variability. Even unpredictable impacts from human activities make testing and applying the idea a challenge for managers. However, given possible conditions, the concept can be applied to reserve management and restoration. The concept could be used in combination with other concepts (e.g., irreplaceability, representativeness, complementarity), as the baseline for defining classification and expansion for individual reserves and reserve networks.

2.2.2 Approaches

(1) Coarse and Fine Filter. Coarse and fine filter is an approach used to capture representation in areas targeted for conservation. Fine filter approaches focus on particular species or habitats, whereas coarse filter approaches focus on maintaining a diversity of habitats or conditions, such as using representation analysis (Hunter 1988, 1996, 1999; Hunter et al. 1988; Noss and Cooperrider 1994; Haufler 1999). Fine filter approaches have the advantage can be effective in

managing any area that has adequate species information at a small scale. The major problem of the fine filter approach is that it focuses mainly on single species and fails to capture other elements in the area.

Coarse filter approaches are advantageous when used to capture many elements in an ecosystem (e.g., species, landscape) at larger scales, which could meet a wide range of conservation objectives (e.g., ecosystem services, ecosystem health, ecosystem integrity, range of variability). However, the lack of connectivity and size of areas is a problem in many parts of world. Most remaining areas are fragmented; thus applying this approach is difficult. However, because the coarse filter approach often uses Geographic Information System (GIS) as a major tool, the approach could be applicable in designing a reserve network, or reserve management in matrix areas (i.e., containing both reserve and non-reserve areas). The approach is currently applied in developed countries (e.g., Gap Analysis) and is gaining more applications in developing countries (e.g., South Africa, Reyers et al. 2001). Lack of adequate databases is an obstacle to applying this concept.

In addition to applying coarse and fine filters approaches separately, both could be used simultaneously. For example, Hansen et al. (1999) propose a dynamic habitat and population analysis to integrate coarse and fine filters approaches in a portion of the Greater Yellowstone ecosystem. Another possibility for applying these two concepts is in areas where data concerning focal or surrogate species (e.g., keystone, umbrella species) are available, the fine filter approach could be used to select individual areas, and coarse filter could later be used complimentarily in reserve expansion. Even in areas lacking information on focal or surrogate species, a manger could first apply a coarse filter to protect the areas, and then incorporate a fine filter based on representativeness, complementarity, or irreplaceability concepts. This could be applied for reserve expansion, reclassification, management, and monitoring individual reserves and reserve networks. The limitation on applying these concepts is that data may not be available for both at the same time. While fine filter requires demographic and distribution data, multiple types of data are needed for coarse filter.

(2) Complementarity. Complementarity describes an area when added to any existing reserve could increase efficiency or representation of diversity of the reserve (Pressey et al. 1993, Williams 1998). The complementarity approach was developed based on the notion that including additional targeted species, habitats, or units to existing protected areas would significantly increase species richness or representatives in the system. An advantage to applying this concept is that it is well suited to supplement existing reserve networks (Williams et al. 1996). The approach has been widely applied. Examples include reserve selection in Uganda (Howard et al. 1998) and South Africa (Reyers et al. 2000, Turpie et al. 2000, Fairbanks et al. 2001), area identification for conservation in Thailand (Kitching 1996), and area prioritization based on endemic species and species richness in Mexico (Peterson et al. 2000) and based on rarity in Canada (Sarakinos et al. 2001).

Studies that used complementarity-based methods were summarized by Rodrigues and Gaston (2002).

However, the concept does not guarantee long-term existence of biodiversity because it ignores the maintenance of natural processes, species turnover, and threats in conservation areas (Reyers et al. 2002). Since this approach requires a good database and technology (such as GIS to help identify gaps or add new areas), major problems in developing countries are the availability of data and lack of GIS technology. Another issue is missing species in the targeted areas or lack of land units. When these limitations do not exist, the complimentarity approach could be applied with gap analysis by adding surrogate or focal species, as well as surrogate units, in reserve design and selection. This approach could also be used in conjunction with identification of irreplaceability and representativeness to increase the adequacy of individual reserves and reserve networks.

(3) Focal Species/Units. Focal species, or focal groups, are species or group of species used as a focus of concern in conservation actions and management because of their requirements for survival represent factors important to maintaining ecologically healthy conditions (Miller et al.1998, Fleishman 2000). Focal species or focal groups could be indicator species, which are species used to indicate sensitive changes in an ecosystem (e.g., ecological/ environmental changes) and are useful in monitoring quality of habitats; keystone species, which are species which play major roles in ecosystem functions and processes through

their activities (e.g. predation); flagship species, which are charismatic species used to campaign for conservation objectives; and umbrella species, which are species that cover a large area in their daily and seasonal movements (Mills et al. 1993, Lambeck 1997, Miller et al. 1998, Simberloff 1998, Hansson 2001, Lawton and Gaston 2001, Menge and Freidenburg 2001).

The concept of focal species has been developed through single species management. With the different roles that species play, as well as the need to use species to accomplish goals based on limited data and resources, focal species have been widely used in most aspects of protected area management. However, using the wrong focal species to represent targeted species and the lack of available data, as well as lack of lands to be protected, are still limitations in applying this concept (Zacharias and Roff 2001). In this circumstance, alternative species (e.g., dominant species or vegetation units) could be used instead of focal species. In this case, focal units may be viewed as surrogate units.

If data are available and resources are in place, focal species such as mammalian carnivores can contribute to protected area management in ecological roles (keystone species), management roles (umbrella species), public relations (flagship species), and in monitoring quality (indicator species) (Miller et al. 1998, Carroll et al. 2001). For a reserve system, focal species could play a significant role as indicator species in monitoring, as keystone species in reserve selection, as flagships in campaigning for specific species, and as umbrella species in reserve expansion. They are also used in combination with other concepts. For example, keystone or umbrella species can be used with gap analysis as target species to identify unprotected areas, with complementarity, representativeness, or irreplaceability for reserve expansion or reclassification, and with the concept of source and sink population in reserve design and connectivity.

(4) Surrogate Species/Units. Surrogate species, groups of species, and factors in an ecosystem (e.g., vegetations or geological types, or environmental factors, functional groups) are used as substitutes for other species or groups of species to meet conservation goals. This concept has been used because of the limitations of resources and data to identify trends in species or characteristics of interest. However, a problem occurs when surrogate species or units do not represent targeted species or units (Caro and O'Doherty 1999, Andelmen and Fagan 2000, Lindenmayer et al. 2002, Lombard et al. 2003). The major concern is how to choose the right surrogate species, since we are often biased towards existing species that we know best, even though they may be poor surrogates. Scale may become an issue if surrogate units represent at one scale but are extrapolated to represent another scale. Also, there is ambiguity because the term "surrogate" is often used interchangeably with "focal species" since sometimes focal species and surrogates species play similar roles. For example, some focal species could also be surrogate species if they represent other species in reserve design, selection, expansion, prioritization, and monitoring. However, surrogate species are not

necessarily the same as focal species if surrogate species are used for other purposes other than are focal species or are not of direct interest to conservation. Recently, surrogate species or units have been applied with hotspots, complementarity, and irreplaceability in reserve management.

(5) Hotspots. A hotspot is an area of high concentration of species (e.g., richness, rare, endemic) that faces high threats (Reid 1998, Myers et al. 2000, Myers 2001). The hotspot approach was developed because of recognition of the high value of biodiversity and concern over the high rate of exploitation of natural resources resulting from habitat destruction and fragmentation. Because of this concern and the limitation of resources, the hotspot approach gives hotspots top priority among areas to be protected. For example, Dinerstein and Wikramanayake (1992) used a conservation index based on size, remaining habitats, deforestation rates, and biological richness to identify conservation potentials, threats, and strategies for 23 Indo-Pacific countries. Myers et al. (2000) defined 25 areas spread throughout the world as hotspots for protection. Hotspots may benefit by protecting key species, areas, or ecosystems, especially under limited resources, but a bias may occur when availability of data on the richness of rare species or threats is inconsistent among areas. More importantly, some areas ("coldspots") that are not designated as hotspots simply because they do not harbor few key species may play a key role in the ecosystem (Kareiva and Marvier 2003). Since hotspots is an approach used to identify and prioritize an area for establishing a new reserve and

funding existing reserves (Dinerstein and Wikramanayake 1992), the approach could be used to identify additional areas for expansion or reclassification to support stronger protection as well.

Since a hotspot could be an area containing species which may be rare, or endemic, groups of species, surrogate species or units, or focal species or units, the approach can be applied broadly in combination with other concepts. For example, to identify areas for prioritization, endemism was applied with phylogenetic history in South Africa (Linder 1994) and was applied using GIS in the Amazon (Kress et al. 1998). Rarity hotspots can be used with gap analysis, complementarity, representativeness, or irreplaceability to identify unprotected significant areas; to include key areas into individual reserve or reserve networks; and to create new areas as corridors or stepping-stones in reserve connectivity. It is also applicable to identify an area in long-term monitoring projects in protected area management. The main difficulty in applying this concept with others in some developing countries is the lack of updated data and technology.

2.2.3 Conservation Goals

(1) Ecosystem Health. A healthy ecosystem is one which is stable and sustainable, maintains its organization and autonomy overtime, and has resilience to stress (Rapport 1995, Rapport et al. 1998a). Ecosystem health is different from forest health, which is considered at a smaller scale as the ability of forests to

recover from natural and human caused stressors or resilience to change (Kolb et al. 1994, Edmonds et al. 2000). Similar to ecosystem service and integrity, the concept of ecosystem health had different meanings for different people and has been a controversial topic in ecosystem management. Though much research has been conducted on impacts from human activities, none has been attempted to look at the health of protected areas. There are several attempts to quantify the health of an ecosystem as well as suggestions for criteria and indicators that can be used to assess and measure ecosystem health (e.g., Schaeffer et al. 1988, Cairns et al. 1993, Yazvenko and Rapport 1996), but these proposals are still rarely applied since the applications are data intensive. No method is widely used in different parts of the world, and the health of functions of the ecosystem still need to be investigated. Focal species and surrogate units (e.g., environmental criteria) could be applied to monitor ecosystem health at different scales. The concept can be used in monitoring impacts from protected area management (e.g., Burkman and Hertel 1992), but it may be costly when applied on the ground. Extrapolation and scale are still major concerns for this concept.

(2) Ecosystem Services. Ecosystem services are the range of services generated by a complex natural cycle that sustains and supports life functions. These services are the conditions and processes sustain and fulfill human life (Daily 1997b). Maintaining ecosystem services is frequently a major goal of protected area management. Humans have benefited both directly and indirectly

from services provided by protected natural resources (Myers 1997, Tilman 1997, Peterson and Lubchenco 1997, Raven 2000). Though people understand the benefits, many times people ignore ecosystem services and take them for granted. The concept cannot be applied as directly as many other concepts in reserve design and selection, but it should be considered as a major criterion in establishing an area for protection. For example, Thailand uses the ecosystem services provided by watersheds (available water), the nation's timber requirement, and land suitable for preservation and development purposes in specifying the percentage of forest areas needed to be protected (RFD 1993b, 1993c, see Chapter 3 section 3.2.2). Though this criterion is not adequate to provide habitats for many wildlife species, one metric of minimum forest area needed for particular ecosystems services could be used in combination with ecosystem health and ecosystem integrity in assessing protected areas needs.

(3) Ecological Integrity. Ecological integrity is the combination of physical, chemical, and biological integrity in an ecosystem, which implies an unimpaired condition or state of being complete (Karr and Chu 1995). Ecological integrity is one of the most important concepts in conservation biology (Karr 2000, Pimentel et al. 2000), but it may be the most difficult to understand. Because of this difficulty, ecosystem health is sometimes mistakenly considered to be synonymous with ecosystem integrity (Kimmins 1996). As noted by Noss et al. (1999), an ecosystem may be healthy but lack integrity. Though there have been attempts to quantify an

index of integrity (Ulanowicz 2000, Andreasen et al. 2001), little is known about the level of resistance required for each ecosystem to withstand and recover from disturbances introduced by human activities. Because of lack of predictability due to changing environments, we may only guess at an ecosystem's integrity based on its withstanding and recovering from catastrophic events (e.g., flooding, insect and fire outbreak). Because the integrity of ecosystem has primarily been viewed abstractly, ecological integrity is rarely applied to reserve management. Despite this, ecological integrity should be applied as ultimate goal of protected area management both for individual reserves and reserve networks (e.g., Robert et al. 2003b).

(4) Naturalness. Naturalness is the condition of being natural (Maser 1990, Taylor 1990), which is the unimpaired nature of an area from human uses. The naturalness concept has been used as a major criterion in park management. Though it has long been used, naturalness is somewhat subjective and means different things to different people. Some people may think that in general, the naturalness is based on an area having no, or minimal, influences from human, which is rarely the case. Also, because most areas are disturbed and the meaning of this concept is abstract, the application of this concept is still limited in protected area management. However, some may apply naturalness only to remote-areas such as the arctic natural wildlife refuge.

(5) Representativeness. Representativeness is a measure of the degree to which protected areas portray the biological and physiographic of diversity of the whole, which is the proportion of the features in an area relative to their original extent in the natural region (Mondor 1990). Representativeness is the representation of units such as species, habitats, landscapes, regions, or environmental units (e.g., climatic and edaphic, Belbin 1993) in an area. Representativeness is primarily used when establishing a new park by considering key criteria, such as wildlife and plant species, geography, or beauty of areas, as representatives of preserve areas. Major problems in applying this concepts are: (1) we may not know if a reserve would fully protect an ecosystem since we do not know all representatives, (2) how much is enough for each representation is still questionable since the question of how many species are needed for an ecosystem in one area is still controversial, and (3) species may be representative at one scale but not at another (e.g., endemic species represent at the local scale but not at regional scale).

Representativeness is based on an assumption that to fully and effectively preserve natural resources, reserves need to protect all key units in the region such as species, groups of species, regions, ecosystems, and groups of classifications (Mondor 1990). Representativeness is a widely applicable concept. It been applied in various stages of terrestrial and marine protected areas from reserve prioritization, design, and selection (ANZECC 1998, Day and Roff 2000, Brooks et al. 2001, Roberts et al. 2003a); reserve management (Nilsson and Gotmark 1992, Pressey et al. 1997, 2002, Pressey and Taffs 2001b, Jepson et al. 2002); and performance of reserve network (Rodrigues et al. 1999). Representativeness has also been applied to both individual reserves and reserve networks with gap analysis to identify areas for conserving biodiversity such as in Queensland (Mackey et al. 1988) and Costa Rica (Powell et al. 2000).

(6) Irreplaceability. Irreplaceability describes as a contribution of an area to a reserve goal, or the extent to which the options for conservation are lost if the site is lost (Pressey et al. 1993, 1994; Pressey 1999; Pressey and Taffs 2001a). The irreplaceability concept gains more attention when any key habitat becomes a major concern in the sustaining of the existence of an ecosystem. A number of applications of this concept have been researched in defining areas that should be protected to ensure the adequacy of reserve networks (Richardson and Funk 1999) and for scheduling conservation actions when available resources are limited (Pressey and Taffs 2001a). However, a limitation of applying this concept is the difficulty in defining, based on sufficient data, which units are irreplaceable since there often is no a priori reason to justify for selection. Identifying the wrong units for inclusion may produce unexpected impacts to the system. However, the concept can be applied with gap analysis for reserve selection, expansion, planning, and management by including irreplaceable target area into individual reserves or reserve networks (Pressey 1999, Richardson and Funk 1999, Noss et al. 2002).

2.3 A Summary of Problems and Suggested Applications

In designing nature reserves, the question "what should be protected" is critical. Many studies have been done to suggest criteria to use to consider what and where to protect (Usher and Margules 1981, Bolton and Specht 1983, Smith and Theberge 1986, Pressey et al. 1993, Caldecott et al. 1994, Department of Conservation 1994, Johnson 1995, McNeely 1996, Green et al. 1997, Williams 1998). Criteria that have been widely used to evaluate target species or areas often rely on international categories, such as the IUCN red list (IUCN 2001). Though the list is widely used all over the world, the practical criterion should be based on local, national, or regional lists of endemic species, or lists of species under national laws. For example, major criteria used in Thailand to declare a wildlife sanctuary are the rarity and richness of wildlife species that are listed as reserved species under the Wildlife Conservation Act and the status of protected species under ministerial decree, which are provided by the Wildlife Conservation Act. To protect wildlife habitats, the Thai Royal Forest Department may declare any area, in accordance with species lists, as a wildlife sanctuary if that area is considered to provide significant habitats for wildlife species.

In reality the place chosen for protected status frequently is based on the locations of species or habitats that have been singled out for protection. A lack of habitats to protect may become the big problem in many developing countries.

Limited data, lack of technology, unavailable lands, and insufficient political power to control available lands also restrict the designation of appropriate protected areas. Often protected areas were designated based on political reasons. Where to protect becomes a more crucial question when resources are limited.

Conservation concepts and approaches that can be applied to identify target species or areas for protection are coarse and fine filters, complementarity, focal species or units, surrogate species, and hotspots. In short, two main criteria that could be applied are (1) species or habitats that are rare, under threats, or fragmentation, e.g., IUCN status (threatened or endangered), international agreements such as Association of South- East Asian (ASEAN) heritage and national parks for ASEAN nations, national lists; and (2) species or habitats that still exist in good conditions.

In general, in-situ conservation, which is conservation of ecosystems, natural habitats, and species in their natural surroundings (Maxted et al. 1997, Maxted 2001), is the major approach used to protect species or habitats. Ex-situ conservation, which is conservation of biodiversity outside natural habitats (Hawkes et al. 2000, Maxed 2001), could be an option to save some species that face high threats before introducing those species back to the original habitats. When considering setting up a nature reserve by using an in-situ approach, the first question to ask is how to choose the most important (or critical) lands to protect (under limited resources), and what type of reserve is the most appropriate. These make reserve types, reserve prioritization, and reserve selection becoming crucial steps.

Whether to establish individual reserves or networks depends on the major objectives of conservation. In theory, if available lands are not fragmented, individual reserves can be established; but in other cases, if targeted lands are isolated, a network of reserves should be considered. However, in the real world, selecting any area is much more complex. Lands are limited and fragmented. Many of them are a mosaic with multiple ownerships and face high threats. Since establishing individual reserves is not simple, setting up reserve networks and creating connectivity are much more difficult. Many approaches used in prioritization and selection rarely address these problems, but consider targeted lands as static units. Lands, especially in developing countries, are dynamic with pressures from the population and threats around targeted areas. Though some workers suggest including socio-economic factors in prioritization (e.g., McNeely 1996), the situation in the real world is still difficult since people still encroach lands and extract resources from protected areas.

Conservation biology concepts, approaches, and goals that may be applied in reserve selection after knowing how much land is available and the conditions of targeted lands (e.g., any conflicts related to targeted lands) are source-sink population, representativeness, irreplaceability, complementarity, focal species, surrogate species, and hotspots. For example, by including both source and sink areas for individual reserves, as well as connectivity (e.g., corridors and stepping stones) for reserve networks, into reserve selection, sink habitats may become source habitats through either restoration process or reintroduction via ex-situ approaches.

Besides considering available lands and resources, criteria that can be used in choosing an appropriate approach to design reserves rely mainly on the targets and objectives of protection and their appropriate spatial and temporal scales. Although a number of approaches have been developed (see section 2.2), fine filter and coarse filters are most commonly used.

The application of coarse or fine filters depends on the conservation objectives, data available, resource support, and expertise. Since some developing countries do not have all of these resources, many approaches suggested above may not currently be applicable. The current system is to use existing records with insufficient resources. However, rapid assessment and some conservation concepts and approaches could be applied in some circumstances. For example, if the objective is to protect species, the concept of focal species (e.g., indicator, keystone, umbrella, or flagship species), surrogate species (e.g., species richness, rare species, and endemism), or source-sink populations should be considered. If the objective of conservation is to protect specific areas, then surrogate types (e.g., vegetation types, geological types, environmental types) and other criteria (e.g., representativeness, range of variability, irreplaceability) might be an option.

When choosing to use species, area, or both, as criteria in designing a nature reserves, the scale of interest can be scaled up from local to landscape, regional, or continental, depending on the species distribution and how large and complex the areas are. From this point, we can consider how much land is available and how much is enough.

How much protection is enough is one of the most difficult questions in conservation biology. Because no one knows how much is enough to preserve integrity of lands, answers vary and depend on objectives of conservation, approaches used, available land, and conservation targets. For this reason, how much land is enough, either maximal or minimal land areas, to guarantee ecosystem health, services, integrity, or to stabilize ecosystem processes, is difficult to quantify. Though the lands that should be protected could be defined directly from an area approach, or be converted from habitat needs by single or multiple species, it still a difficult task in developing countries due to the lack of updated databases.

To determine how much land is enough, two criteria that can be used are area and arbitrary conservation targets. For the first approach, there are attempts to estimate targeted conservation areas from species needs and available lands to be protected. Conservation concepts related to this approach are: MVP (Minimum Viable Population), which can be converted to MAR (Minimum Area Requirement), and island biogeography. More examples of using conservation biology concepts to designate how much land is enough and how to select and manage nature reserve are discussed in Chapter 5.

2.4 Discussion

When applying concepts or implementing work that has never been tested or has only a few tests in the real world, two questions need to be asked. One is, "what are the obstacles that may obstruct implementation or success?" The other is, "what are factors that might facilitate successful concept implementation?" In the former case, information gaps and logistical feasibility can be major problems. Many times concepts are not applied well because they are developed from one species, group of species, environment, or scale, but are applied to a different species, group of species, environment, or scale (Hobbs 1988). Information gaps play a crucial role, both in developing and developed countries. Logistical feasibility, such as expertise and capability of human resources, available databases, and technology, are crucial for testing and applying all concepts mentioned above, but many countries all these are still lacking (Harmon 1994). To facilitate and make implementation work, all these infrastructures have to be in place and used efficiently.

Scaling and using the right concept with appropriate information are crucial issues in applying concepts. For the scale issue, managers need to be aware that some concepts may work well on a small scale but not on larger ones. For example, a concept may work well with individual reserves but not work when applied to reserve networks. For the issue of combining application concepts with appropriate information, many times managers choose to apply a concept with not enough, inaccurate, or outdated data. Therefore, managers have to make sure that the information gap is not an issue, and logistic feasibilities such as adequate technology and expertise should be in place.

2.5 Conclusions

In many developing countries, a lack of updated databases (wherein recorded species may have unknown numbers, or be entirely loss from the areas), a lack of supporting resources (e.g., manpower expertise, technologies), and high pressures from population growth are still major problems that might be hurdles to the success of applying concepts and approaches. Many tools, concepts, and applications suggested recently in scientific journals require adequate data and resources. Few (e.g., Freitag et al. 1998, Polasky et al. 2000, Pressey and Taffs 2001a) are suggested in situations where data is lacking and threats are high. It is no surprise that to protect natural resources in a rapid changing world, ad hoc and rapid assessment approaches are often used in many parts of the world, though the consequences may eventually be costly (Pressey 1994, Pressey and Tully 1994).

Many concepts in conservation biology are still new, some have inadequate supporting evidence, and some have never been tested in the field. It would be beneficial if managers could test the concepts and evaluate them in actual situations. More importantly, managers should keep in mind that concepts that work in one area may not necessarily work in others.

In conclusion, it is not easy to apply conservation concepts to reserve management in a complex and rapidly changing world. Some concepts may require considerable time to test, while quick, reasonable decisions and solutions to slow down the rate of extinction are often needed. However, application of these concepts should be considered whenever resources are available.

Chapter 3

Protected Area Management in Thailand: Past, Present, and Future

3.1 Introduction

Thailand uses protected area systems for protecting biodiversity by modeling formats and approaches from western countries such as the US National Park and IUCN systems (Brockelman 1990). In the last 4 decades, Thailand declared 102 national parks, 55 wildlife sanctuaries, 67 forest parks, 48 non-hunting forest areas, 15 botanical gardens, and 54 arboretums, covering 90,506 km^2 (17.6 % of land area, or 52.7 % of forest area), not including conservation zones in watershed areas, mangroves, and national forests (RFD 2002). Increases in protected areas were significant between 1996 and 2001 (Figure 1), especially for number of national parks (Figure 2). National parks and wildlife sanctuaries are distributed throughout Thailand, but are most prevalent in the western portion of the country (Figure 3). Though there has been much success, problems related to protected area management in Thailand are the center of discussion at international levels (Vandergeest 1996b, 1999; Dearden et al. 1998). Many discussions focus on general characteristics, history of protected areas, and problems in specific case studies (e.g., Poffenberger 1990, Albers and Grinspoon 1997, Bugna and Rambaldi

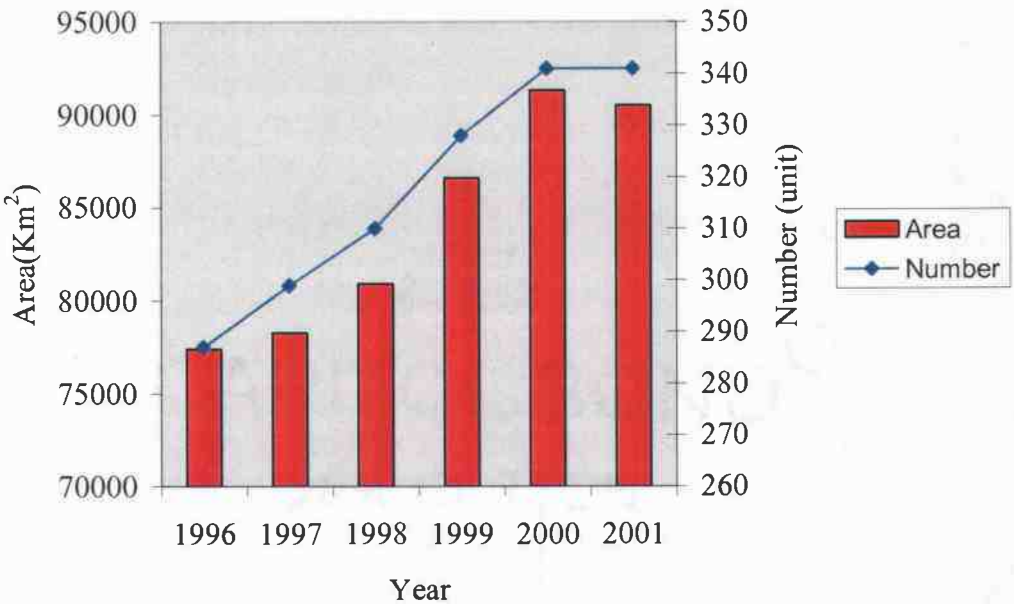

Figure 1. Area and number of protected areas in Thailand.

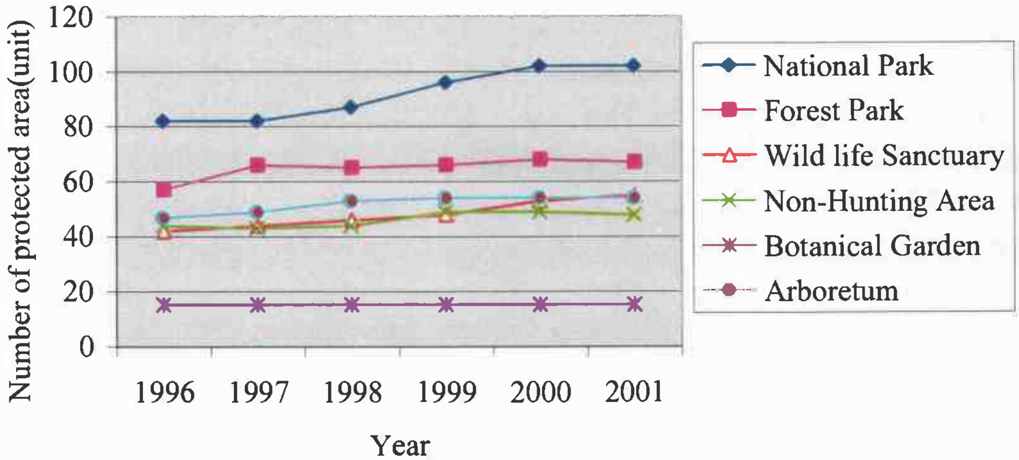

Figure 2. Number of protected areas by category.

2001, Sato 2002). Besides the reviews by MacKinnon and MacKinnon (1986), MacKinnon (1997) and Kasetsart University (1987), evaluation and assessment of the protected area system and its management are lacking for Thailand. A lack of understanding of problems frequently leads to misunderstanding problems in protected areas management. Therefore, in this chapter, I present an in-depth review of protected area management in Thailand. I will address several questions: What are the definitions, categories, legislations, and policies of protected areas management in Thailand? What are the concepts, tools, and approaches the RFD has used to design, select, and manage reserves? What are major problems and constraint in managing protected areas in this country? What options are available to resolve those problems?

To answer these questions, I review literature, government documents, peer-reviewed publications, and unpublished reports related to protected area management in Thailand. In addition, I interviewed 21 staff of RFD who have worked in protected area management in the last three decades. To gain a broader view of the issues and problem solving in protected area management, I also discussed issues with experts from the Faculty of Forestry, Kasetsart University in Thailand.

The objectives of this chapter are to 1) review the concepts, approaches, tools, and status of protected area management in Thailand; 2) identify gaps in the work of conservation, and threats and conflicts in protected area management; and

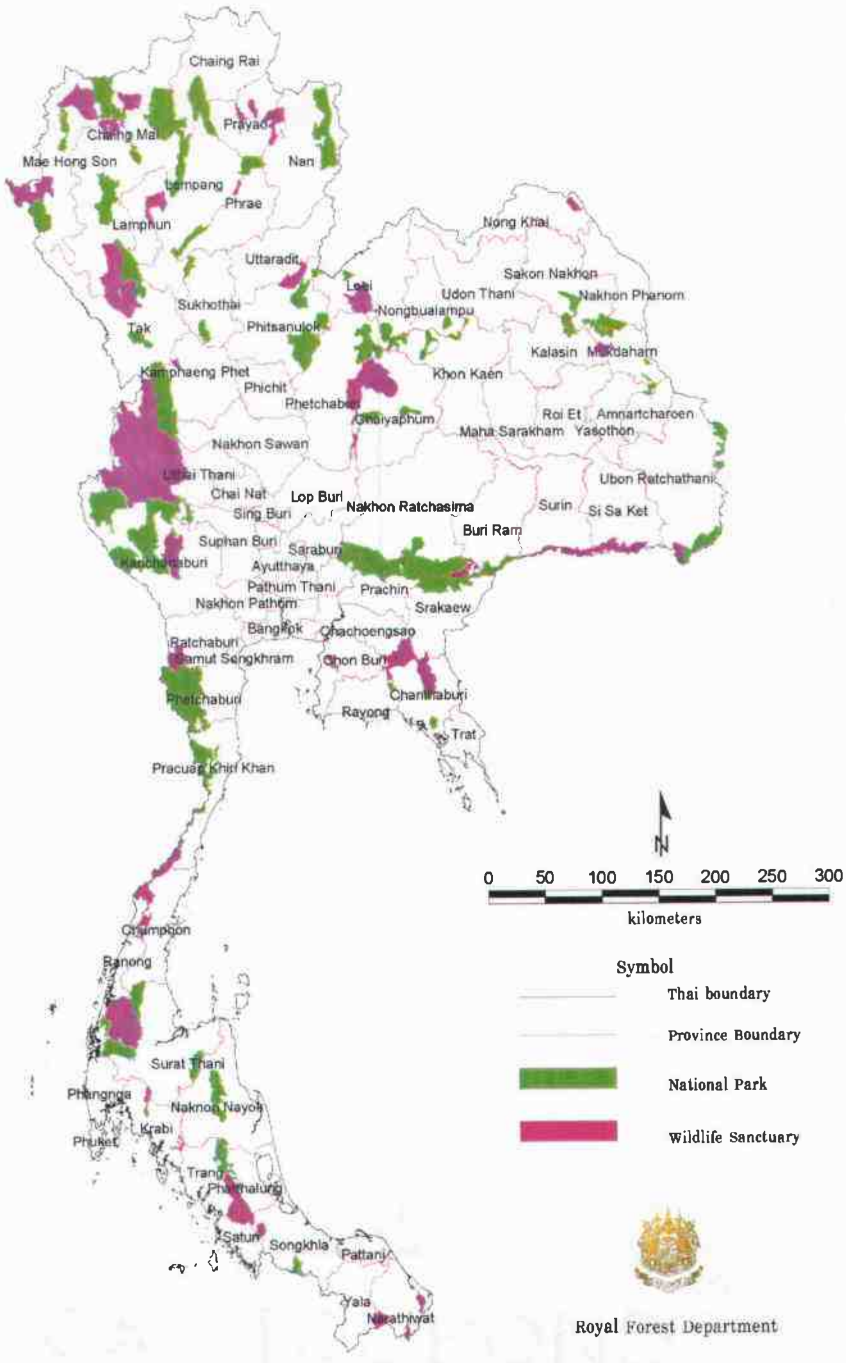

Figure 3. National parks and wildlife sanctuaries in Thailand.

3) discuss the alternatives and how to improve protected system and management. I begin this chapter by describing the success and work that need to be improved in protected area system and management. I follow this with a brief description of the strategies, concepts, tools, and approaches currently used. I then illustrate the importance of economic valuation and monitoring in protected area management. In the following section, I discuss current situation and provide an overview of major threats in protected areas. In each section, I suggest alternatives to improve protected system and management. Though details are from protected areas in Thailand, the findings could be applied throughout Southeast Asia and other regions as well.

3.2 Protected Area Management in Thailand: A Brief Review

3.2.1 Protected Area System

(1) Definition of Protected Areas. Different groups in Thailand interpret the term " protected areas" in different ways. Their understanding relies on perceptions and criteria used for definition. There are also discrepancies in understanding the meaning of protected areas among the staff of the RFD. For example, according to the RFD Information Office, the RFD classifies protected areas into three categories, defined by (1) national laws (e.g., national parks, wildlife sanctuaries, non-hunting areas), (2) laws at ministerial and departmental levels (e.g., arboreta,

botanical gardens, non-hunting areas), and (3) government policies or cabinet resolutions (e.g., zone C in mangrove forests, national forests) (RFD 1996b). Some staff of the RFD consider protected areas to be only those defined by Wildlife Conservation Act B.E. 2503 (1960) and amendment 2535 (1992) for wildlife sanctuaries and non-hunting areas, and by the National Park Act B.E. 2504 (1961) for national parks. Other RFD staff include areas outside national parks and wildlife sanctuaries, such as zone C in national forests, mangrove forests, and watershed areas. Still others include botanical gardens, or arboreta (RFD 1993b).

Since the criteria used to define protected areas are not widely understood by the public, people who live adjacent to protected areas have the perception that whatever the definition is, protected areas are designed and protected by laws and belong to the RFD. These two problems, misunderstanding among the staff of the RFD and misconceptions of the public, lead to difficulties in communication between the RFD and the public. Because most people do not understand what "protected area" means and how it is important to them, conflicts of land uses will exist as long as people think of protected areas as simply belonging to the government, and do not accept the privileges and responsibilities that stem from collective ownership.

(2) Categories of Protected Areas. The IUCN has attempted to standardize international categories of protected areas by placing protected areas into six categories based on objectives of management (IUCN 1994). However, categories

differ among countries. Though categories of protected areas in Thailand do not follow the IUCN system directly, there are some analogous categories. For instance, the Thai concepts of "wildlife sanctuary" and "national park" are analogous to Categories 1 and 2 of the IUCN system (Galt et al. 2000a, 2000b).

Thailand has used its current protected system since 1960 (RFD 1994, 1996b). The categories were established under two major laws: the National Park Act and the Wildlife Sanctuary Act. Other categories of protected areas (e.g., botanical garden, non-hunting areas) are developed under the provisions of umbrella laws. However, there are discrepancies in categorizing protected areas among groups of people. For example, the RFD classifies protected areas into three categories following the definition mentioned above (RFD 1996b), while a 1987 Kasetsart University's report categorized protected areas similar to IUCN using 6 categories (KU 1987). In the meantime, a Finnish report (Thai Forestry Sector Master Plan) classifies protected areas into 11 categories (RFD1993b) and the Mekhong International Development Associations (MIDAS) report defines 2 categories (MIDAS 1993). In short, there is no consensus on how many categories of protected areas exist.

Though the number of categories has no obvious effect, the categories chosen for implementation can affect human impacts on protected areas. For example, human activities (e.g., recreation) are allowed in national parks but usually are not allowed in wildlife sanctuaries (RFD 2000, 2001b). Lands categorized as wildlife sanctuaries or national parks are strictly protected, while other categories (e.g., national forests) may not be well protected by law. The main concern of local people is the level of access to different areas, and how vigorously that level is enforced by the government. Though in some protected area categories may not actually affect public access, differences in penalties received under different classifications may indirectly influence public perception and pursuit of illegal activities. To strengthen protected area management, the RFD may need to recategorize some protected areas so that the level of protection is more clearly communicated.

3.2.2 Protected Area Management

(1) Legislation Relevant to Protected Area Management. Protected area management in Thailand uses area control as a major strategy under strict laws, including the Wildlife Reservation and Protection Act B.E. 2504 (1960), amended B.E. 2535 (1992) for wildlife sanctuaries and non-hunting areas, and National Park Act B.E. 2504 (1961) for national parks (RFD 1994, Galt et al. 2000a). Other types of protected areas (e.g., botanical garden, arboretum) administered by the RFD under the regulation set by MOAC, use protections strategies to manage protected areas by creating laws through the House of Representatives. Laws used in managing outside protected areas (e.g., national forests, buffer zones) include the Forest Act B.E. 2484 (1941), Forest Preservation Act B.E. 2504 (1961), National

Reserve Forest Act B.E. 2507 (1964), Forest Plantation Act B.E. 2535 (1992), and cabinet resolutions (Charoenpanij 1993, RFD 1996).

Because Thailand lacks a unified protected area policy to guide and manage areas, the RFD relies mainly on laws (Chettamart personnel communication), regulations set by the MOAC, and cabinet resolutions (Panyapornvittaya, personnel communication). However, relying on law cannot keep pace with rapidly changing situations in a changing world. Relying on regulations of MOAC is also problematic because they are created by ministers who often pander to interest groups within their parties.

Since politics in Thailand have been unstable for the last four decades and conflicts in land management have accumulated from previous governments, many groups, both rich and poor, have used instability to promote their own agendas to take control of natural resources through cabinet resolutions (Panyapornvittaya, personal communication). If the Thai government does not resolve this problem, the country will face serious long-term conflicts in protected area management. No one can identify the best solution as each case is unique. A possible result of this case-by-case approach is that the RFD may lose forest areas because government officials tend to look after the needs of their supporters first. Therefore, if the government is concerned with the security and prosperity of the country, which rely on protected areas, it should not be quick to surrender forestlands to any group.

(2) Policy Relevant to Protected Area Management. Because the RFD has never had a protected areas policy at the national level, the department has relied mainly on the laws and cabinet resolutions mentioned above, and other policies at the national level (e.g., five- year National Economic and Social Development Plan (NESDP); national forest policy, RFD 1985). Despite some policy guidelines recommended for protected area management (e.g., IUCN 1979a, 1979b; Pongroongsup and Pitayakajornwute 1989; Kutintara, 1994a, 1994b), these recommendations are rarely implemented on the ground. Because of a lack of specific policies at the national level, the RFD manages protected areas with little direction and cannot resist the pressures from outside the department. In the past, the National Economic and Social Development Board (NESDB) used a top-down approach to set up a five-year NESDP focusing on development of the country. The five-year NESDP was created to advise economic goods but lacked the vision to protect forestlands, despite the fact that it addresses how the country ought to respond to natural resources crisis. Also, despite the target under the national forest policy stating that the country should have 40% of its land in forests (25% for protection forests and 15 % for production forest; RFD 1993b, 1993c, Nootong 2000), these guidelines rarely gained attention from the public, in part because the actual amount of remaining forest areas is controversial. The 40% figure was based on the calculation that this amount of forest would provide water resources throughout the country, the nation's timber requirement, and land suitable for

preservation and development purposes (RFD 1993b, 1993c). Recently, the national environmental plan suggested 50% as the target percentage of forest area (OEPP 2003). Though the government is unclear of how much area to preserve, there is still argument about the quality of the 33% of forested area remaining in the country (RFD 2002).

(3) Protected Area Planning. RFD has used a five-year master plan as a guideline for managing protected areas. After five years, the plan is reviewed and a new plan is prepared for the second phase. In the past, preliminary plans were used in some protected areas while formulating the master plan. As of 2001, the RFD had master plans in 80 protected units (56 of 102 national parks and 24 of 55 wildlife sanctuaries) (RFD 2001b, 2002). Though there are still attempts to formulate a comprehensive master plan, this has not yet been accomplished. Also, while much has been done to develop the plans, few have been examined to evaluate how successfully the plan was implemented and its impact on protected area management (e.g., Bhumpakphan and Kutintara 1993, Wongwathana 1995). Because of these gaps in feedback, the crucial questions are: Does the plan really work? If not, what are the causes and consequences of unworkable plans and unsuccessful implementations? Most importantly, can the plans be improved to make them work?

Though the RFD has annual training courses on protected area planning for its staff, four major problems are still obstacles: unavailable planning documents, lack of understanding of plans from the RFD's staff, lack of public participation in the planning processes, and lack of evaluation of planning implementation and monitoring processes. Similar to the way the RFD sets up and manages protected areas (Ruhle, 1964a, 1964b; Vejaboosakorn 1984), the RFD borrowed approaches from the United States and international systems such as IUCN to formulate the plan (Thorsell 1984, Pitayakajornwute 1984, NPS 1986, RFD 1990). Despite using these planning documents, the RFD does not accomplish the most crucial step in formulating a master plan, public participation. When planning does not involve the public, noone knows the characteristics and purposes of the plan. The planning processes are usually formulated by the staff of the RFD and scholars from universities or well-known institutions. Since the plan is established by the RFD, approved by the committees and the RFD, and implemented by the RFD, it is effectively a plan for the RFD - not a plan that the public knows and participates in. This problem has been ignored and has caused ineffective implementation of plans.

(4) Institutional Oversight of Protected Area Management. The Thai RFD is the only national agency responsible for stewardship of federally owned natural resources, including protected areas. The department was initially founded to promote timber production (RFD 1993d), thus its current organizational system reflects two philosophies: conservation of biodiversity and resource utilization. All protected areas are under the jurisdiction of the Royal Forest Department. In 2003, the RFD was formally reorganized into two departments: the RFD, overseeing

productive forest and community forestry; and the Park, Wildlife, and Plant Conservation Department, which oversees protected areas (PWPCD 2003, MONRE 2003). In this thesis, I refer to the RFD as organization that oversees protected areas (national parks and wildlife sanctuaries), even though they are now under the Park, Wildlife, and Plant Conservation Department.

(5) International Convention/Agreements Relevant to Protected Area Management. Thailand has signed and ratified the RAMSAR Convention on Wetlands, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and World Heritage Convention (WHC) (Galt et al. 2000a). Regionally (e.g., ASEAN), Thailand has participated in the Asian Declaration on Heritage Parks and Reserves and the Asian Agreement on the Conservation of Nature and Natural Resources (NPS 1986, Wiryanti 2000, Bugna 2001). However, the country is still reviewing some agreements after signing but before ratifying them, such as the Convention on Biological Diversity (Galt et al. 2000a), the Kyoto Protocol, and the United Nations Convention on the Law of the Sea. Though Thailand benefits from using international agreements as tools to manage natural resources, gaps between international agreements and reality of problems on the ground are still wide. Many agreements are impractical and have few provisions to impact critical conservation issues, such as illegal logging, hunting, land encroachment, and forest fire. Since the scales of the problems and the agreements

are different, policy makers have difficulties creating mechanisms for translating international agreements into practice.

3.2.3 Protected Area Management Strategies

(1) Protected Areas Prioritization. Two major goals in Thailand are to establish new protected areas and to invest resources to protected areas. To establish new protected areas, the RFD has used existence of focal species (based on rarity and species richness), naturalness, representativeness, and threats to determine priorities. RFD also uses the government policy stated in the five-year national social and economics development plan to guide how many protected areas the department should establish (Ampholchan, personal communication). Though it uses reasonable approaches in choosing individual areas for protection, the RFD still needs to apply up-to-date data in establishing protected area networks. Recent developments by Kanjana (2000) for vegetation and key species wildlife sanctuaries, Prayurasiddhi et al. (1999) for design of ecological complexes of protected areas, and Suntajit (personal communication) for presence of key species could be incorporated with previous works done by Jintanugool et al. (1982), Santisuk et al. (1991), and Brockelman and Baimai (1993) to prioritize areas for protection.

In the past, the RFD used factors that might influence protection efficacy (such as size, tourist numbers, management issues) to classify 3 groups of national parks (such as most important, important, moderate) (RFD 1989). This classification was limited to use for investing resources in national parks, not including wildlife sanctuaries and other categories of protected areas. Since then, there have been attempts to identify the potential of areas and prioritize the areas for investment in tourism in national parks (e.g., Forestry Research Center 1995, Sretarugsa 2000).

Since Thailand has never updated the approach to prioritization of investment in protected areas based on ecological, economic, and social needs, the country may under-protect key areas that are under threats. The RFD could apply recently developed conservation tools and concepts to develop the database for all protected units. This would benefit not only the identification of unprotected or under-protected areas, but also the re-categorization of existing protected units and the expansion of individual protected areas, thereby increasing the efficacy of area network protection.

(2) Protected Area Design and Selection. The RFD has jurisdiction to declare any appropriate area as a reserve. Currently, RFD uses 14 steps to establish new protected areas (MNPD 2000b). Approaches used to design protected areas are based on species, areas, or combinations. Though some (e.g., Trisurat 1992, Grainger et al. 1995) suggest applying GIS to improve conservation planning method and protected area management, GIS has not yet been used for selecting reserves at the ecosystem scale.

Though the overall process to design and select protected areas may look similar for different categories of protected areas, the criteria used in each protected area category differ slightly. For example, to set up a new national park, naturalness and representativeness of species and areas are major criteria. To establish wildlife sanctuaries, focal and surrogate species and representativeness are two criteria to be considered. Though the principle objectives of setting up both national parks and wildlife sanctuaries are to protect natural resources and use the protected areas as research laboratories, there are also slight differences in management objectives: national parks usually focus on recreational purposes (MNPD 2000a) while wildlife sanctuaries focus on protecting wildlife species. However, similarities in criteria and objectives can lead to an area being appropriately categorized either as a national park or as a wildlife sanctuary.

During the demarcation of target lands as reserves, two potential problems often occur in Thailand: land conflict and unavailable contiguous area. Land conflicts occur when targeted areas are already occupied. For example, in 2001 there were 500,000 families living inside forests (including national reserve forest and protected areas (RFD 2001c); some of these areas have potential to be declared as protected areas.

(3) Reserve Expansion. RFD has a strategy to adding some unprotected forestlands into the protected system to increase the strength of the system. Most expansion areas are national forests located adjacent to existing protected areas that

are significant to the ecosystems. However, since most forest areas are encroached on and occupied by people, expansion often faces resistance from local to national levels. Because of this, building a reserve network is difficult in many areas. Therefore, the best way to control forest areas is to declare as many forest areas as possible initially. Otherwise, the government will confront more pressures from land use conflicts when implementing an expansion project. Protected area expansion will work in forest areas that belong to the government where no one is using the land (legally or illegally). Therefore, Thailand still has a long way to go to include private lands in a protected areas system.

(4) Re-categorization. The main objective of re-categorization is to strengthen protected areas. To increase the level of protection, two approaches to re-categorization can be implemented: re-categorization to different categories at the same level of protection (such as from a national park to a wildlife sanctuary) and re-categorization to increase the level of protection. Because "wildlife sanctuary" and "national park" are the most effective categories used to protect biodiversity in Thailand, re-categorization from lower levels of protection to these two categories is most frequently implemented approach (e.g., reclassification from national forests to national parks or wildlife sanctuaries, from non-hunting areas to wildlife sanctuaries, or from forest parks to national parks). Though it has been discussed in recent years, re-categorization at the same level of protection (from national park to wildlife sanctuary, or from wildlife sanctuary to national park) has

never been done. Most discussions have focused on changing some wildlife sanctuaries to national parks, primarily to better meet management objectives, to gain economics benefits, or to satisfy political pressures.

(5) Management and Protection. The RFD uses the National Park and Wildlife Conservation Acts as major tools to protect conserved areas. By setting up mechanisms, regulations, and processes provided by laws, the degree of management in protection areas differs in each category of protected areas, depending on which laws the protected areas rely on. Under these laws, the department uses the area control approach in protecting natural resources inside the protected area. Protected areas not covered under these two laws have a lower level of protection.

Because of its reliance on law instead of policy as a direction, the RFD has been confronted with problems in the process of drawing boundaries for management and in protecting against threats from outside the boundaries. For example, although the RFD strictly protects natural resources inside the protected areas, often it cannot efficiently protect against threats from outside. Most areas outside protected units are national forests, overseen by provincial or regional forest offices. These areas could play a crucial role in buffering protected areas but in most cases, they do not because they are located near villages, are already occupied, or have natural resources which are being extracted. More importantly, they receive less resources and attention from the government.

3.2.4 Concepts, Tools, and Approaches Currently Used in Protected Area Management

In managing protected areas, Thailand has borrowed ideas from other countries to manage its protected areas. Area control, borrowed from the US national park concept, has been used to protect natural resources in individual reserves. By placing headquarters in core areas and setting guard stations around the protected units, this militaristic approach works well for areas of high threat from illegal activities, but is controversial in areas of high landuse conflict (Chompoochan et al. 1995). This approach is used in most categories of protected areas in Thailand. In wildlife sanctuaries, the focus is on protecting wildlife species and habitats. In national parks, zoning is a major concept applied to manage the areas. In the area that allows human activities inside the park, the carrying capacity concept is applied. Other concepts, such as the recreation of opportunity spectrum (ROS), limits of acceptable change (LAC), process of visitor impact management (VIM), visitor experience resource protection (VERP), crowding, and nonconforming behaviors, are not widely used, though they were recently studied in some areas (Tanakanjana 1996; Ampholchan, 2000a, 2000b; Dulkul 2001). The buffer zone approach has been tested at Hui Kha Kheng Wildlife Sanctuary, but the results are questionable (Rodenburg 1995). Another project of buffer zone management was establishing at Kaeng Krachan National park (Poore 2003). In addition, there are buffer zone evaluation projects operated by community forestry division in six areas around protected units (Ongprasert personal communication).

Because the philosophies of implementing buffer zones between the community forestry division of the Reforestation Office differ from the National Park Division and Wildlife Conservation Division of the Natural Resources Conservation Office (Ngamcharoen personal communication, Ongprasert personal communication), findings from evaluation projects by community forestry division may reflect organizational differences in buffer zone management.

Few protected area networks are implemented on the ground in Thailand. The Western Forestry Complex, for example, located in western Thailand and jointly implemented by Royal Forest Department and Danish Cooperation for Environment and Development, is a network which ecosystem management is applied (Pattanavibool 2000, Pattanavibool et al. 2002, Trisurat 2003). Though attempts had been made in the National Park Division to set up networks in different regions of the country, those were administrative networks - not ecological ones. Recently, protected area networks between countries was established at Pha Taem Protected Forest Complex, located in northeastern Thailand, to initiate cooperation in tansboundary biodiversity conservation between Thailand, Cambodia and Laos (Poor 2003, Trisurat 2003), the outcome from the first phase of this project is still being evaluated.

In addition, there have been attempts to set up protected area system networks in planning for terrestrial national parks in the east (e.g., Khao Yai – Thap Lan – Pangsida – Ta Phraya National Parks; FRC 1997) and marine national parks in the south (e.g., Mou Kho Surin and Mou Khao Similan National Parks), though they are still rarely implemented on the ground.

Several other approaches such as community forestry, agro-forestry, reforestation projects, conflict management, and eco-tourism (e.g., Wood et al 1995) are also applied in resource management in Thailand. These strategies are usually applied outside the protected areas, such as, along the borders, in national forests, or in watershed areas (but see Emphandhu 1992; Chettamart and Emphandhu 1994, Deardren 1997).

3.2.5 Economic Valuation of Protected Areas

Protected areas in Thailand play a major role in security, society, and economic development of the country (Sabhasri 1987, McNeely and Dobias 1991, Santisuk et al. 1991, Brockelman and Baimai 1993, McNeely and Somchevita 1996, McNeely 2000). Though protected areas have been established under the administration of RFD for more than four decades, little attention has been paid to evaluating benefits of protected areas (but see Dixon and Sherman 1990; RFD 1998a, 1998b, 1999b. Despite public recognition that resources in protected areas provide substantial ecological services, natural resources are still undervalued by the people who depend on them. The public and politicians frequently consider natural resources as common goods that everyone can take advantage of. The public may not understand how important natural resources protected by reserves are until they lack the ecological, social, and economic benefits they provide.

Though economic valuation cannot fully explain all of the benefits of protected areas for the people, it is one approach that might help the public see how important it is to protect natural resources. In Thailand, much has been done to show the importance of development projects to economic development, but little has been done to evaluate the benefit of protected areas in relation to development projects and how much the projects impact natural resources in protected areas. Despite many attempts to determine the economic values of protected areas (RFD 1998a, 1998b, 1999b), costs and benefits of natural resources used, deforestation (Panayotou and Sungsuwan 1989), or Thailand's logging ban (Durst et al. 2001), little has been done to point out the security value of protecting natural resources. An ongoing project supported by IUCN is trying to evaluate benefits of protected areas at national and regional levels in Thailand, Lao PDR, Vietnam, and Cambodia (IUCN 2002); however, additional research is needed to illustrate the importance of protected areas to the country, to the public, why the public needs to support government protection of natural resources, and the social impacts that would result from failure to protect the last remaining resources in the country.

3.2.6 Evaluation and Monitoring

Most protected areas in Thailand lack evaluation and monitoring projects. Managers use annual reports as a major tool to request funding. These reports focus on budgets for hiring workers and maintenance equipment. Although some evaluations have been conducted to assess the implantation of master plans for some protected areas, those assessments were administrative in nature. Most protected areas that have master plans still do not have ecological assessments.

Similarly, few monitoring projects have been implemented in protected areas. Most monitoring projects used remote sensing and aerial photo interpretations to compare land uses changes at different times in the past (Charuppat 1992, 1994). Fewer efforts have attempted to established projects to monitor in the future (e.g., Srikosamatara 2000). Despite some suggestions to monitor biodiversity in tropical forests in Thailand (Boontawee et al. 1995, Boyle and Boontawee 1995, Charuppat 1997), the framework is rarely implemented on the ground. Also, there are few monitoring research projects that have been conducted in marine protected areas in Thailand; one exception is the proposal described by Dearden et al. (2002) to assist marine protected area management. This research program may provide some idea to establish monitoring projects in marine protected areas.

Major problems for evaluation and monitoring projects are (1) projects are not implemented because the framework documents are in other languages; (2)

some managers and staff of the RFD do not understand how or what to monitor; and (3) most managers and staff may not effectively conduct evaluation and monitoring because of lack of time, resources, and support.

3.3 Current Situation of Protected Area Management

Land encroachment, illegal logging and hunting, and development projects have long been major threats to protected areas in Thailand (Suprichakorn 1959, Pradistapongs 1961, Kunstadter et al. 1978, Ives et al. 1980). Other activities, such as recreational uses and their management, introduction of alien species, forest fires, diversion of water, pollution, and management of adjacent lands, also may be significant threats to some protected areas (RFD 1993a, 1993b, 1993c, 1993d). However, in the last four decades government policies and economic development, such as import and export policies that negatively impact the environment and natural resources, have also become major threats to protected areas. Though policy-makers realize that development projects do not compatible with sound environment practices, most projects still lack of measurable impacts to protected areas.

Population growth, government policy, and globalization all threaten natural resources in Thailand. As is the case throughout the world, in Thailand population growth plays a significant role in creating other threats, such as forest fire, land encroachment, and illegal activities, as well as in increasing the degree of existing threats, such as land expansion. Government policies have long created fundamental problems impacting natural resources management in Thailand (RFD 1993a, 1993b, 1993c, 1999d). Examples of government policies leading to decreases of natural resources and forestlands are land reform projects, shrimp farms, rubber tree and oil palms plantations, commercial plantations, road building, and urbanization. These policies also lead to conflicts within and between government sector and the public. Though recently the problems have gained more attention from the government, few solutions have been successfully implemented.

Thailand has made progress by decreasing population growth in the last 3 decades, but has failed to solve problems related to land use policies. Major threats such as land encroachment, illegal activities, and development projects still exist and have increased substantially. If the government does not develop a timely strategy to solve Thailand's protected area problems, there may be few forestlands left to protect.

3.4 Discussion and Conclusions

There are still many gaps in approaches used in design, selection, and management of protected area in Thailand. Boundary conflicts are sometimes the result of unclear boundaries where the RFD establishes new reserves, or encroachment by people. Though using zoning approaches in national parks to ease the problem seems promising, few cases have proved successful. The conflicts may decrease, but there is no clear general solution, and conflicts are unlikely to go away as long as people still rely on using forest resources.

It has long been argued in Thailand (as well as elsewhere) that natural resources management which excludes local people may not succeed. Based on this premise, the central question for the Thai society has remained who should own, manage, and use natural resources? Should natural resources be owned and managed by the government, the private sector, or community, or should they be co-managed by many groups of people in the society? How do we ensure that each group manages natural resources in a way that could provide equally long-term benefits to everyone in the society?

Protected area management in Thailand has resulted in both successes and failures in many areas. In addition to a logging ban enacted in 1989, the country has increased the number and sizes of protected areas. This indicates the intention of society to protect its own biodiversity even while confronting the pressures from increasing human needs, whether for consumption in the country, or for raw material to produce goods for large-scale exporting. Future research should focus on solving these rapidly changing problems. In addition, there is a considerable amount of basic research that needs to be conducted. More importantly, the success in increasing protected areas, together with the increase in conflicts, indicates the failure of the society to manage protected areas in a single direction.

Protected area management in developing nations is a complex societal problem. The problems cannot be solved using any one approach, and cannot be solved by a single stakeholder. The solutions need to be politically viable, economically feasible, and socially acceptable. In the case of Thailand, many stakeholders play significant roles both in creating and solving problems.

Protecting biodiversity in protected areas has to be the first priority for the country. I suggest that many crucial issues related to the system and management of protected areas, such as creating the policies, setting up a protected area system plan, restructuring institutions, increasing protection efficiency, and solving land use conflicts, should be implemented immediately to be most effective.

Chapter 4

Effectiveness of Protected Area Management in Thailand

4.1 Introduction

Designing an area as a protected unit is among the most effective approaches to protecting biodiversity (Mackinnon 1997; Agardy 1997, 1999, Lubchenco et al. 2003). Despite their wide use throughout the world, effectiveness of protected areas, which is the efficacy of the system to protect targeted species, and the efficiency of management to accomplish protected area objectives are still controversial (Bruner et al. 2001a, 2001b, 2001c; Stern et al. 2001). Debates over protected area systems center on their efficacy to contain targeted species or representativeness, and concern over effectiveness of management frequently center on land use conflicts between establishing protected areas and providing for human needs to access and extract natural resources. Though recently work has been done to test system effectiveness in some areas (Singh 1999, Pressey and Taffs 2001a, 2001b; Pressey et al. 2002), the results are still limited. Also, recent approaches, such as buffer zone management, community forestry, ICDP, and sustainable forestry, have been applied as compromises to conflicts to increase management effectiveness (Adams and Hulme 2001, Gray et al. 2001), but the outcomes are still mixed and some approaches are questionable (Newmark and Hough 2000, MacKinnon 2001, MacKinnon and Wardojo 2001). Major negative consequences from these conflicts in turn generate questions about the efficacy of protected areas (Newmark and Hough 2000).

In the last few years, while much work has been done in many regions and countries (Hockings and Twyford 1997; IUCN 1998, 1999; Singh 1999; Rodrigues et al. 1999; IUCN 2000; WWF 2000; Jepson et al. 2002), protected areas in many countries have never been evaluated for effectiveness. For example, although the protected area system and management was reviewed and assessed by MacKinnon and MacKinnon (1986), Kasetsart University (1987), MacKinnon (1997), and Wikramanayake et al. (2002), very little is known about effectiveness of protected area system and management in Thailand. Despite success in increasing the number and sizes of protected units (Chapter 3), Thailand still faces serious and difficult problems in land use conflicts. Though protected areas are considered to be the last frontier to protect biodiversity and contribute greatly to economic development and security for Thailand (Bryant et al. 1997), in the eyes of the public protected area management is still questionable and often negative. Many questions about the effectiveness of protected area are raised: do protected areas really work? If yes, how well? If no, what are the problems: the system, management, or humans who want to use forestlands? And more importantly, how can protected area management be improved?

To respond to these questions, this chapter reports on an evaluation of the effectiveness of protected area management in Thailand based on a review of the literature and documents of the RFD, analysis of questionnaires sent to the heads of protected areas (national parks and wildlife sanctuary), interviews with the staff of RFD who have worked in protected area management in the last three decades, site visits, and discussions with experts who are working in the universities and in the field. The objectives of this chapter are 1) to identify the nature of threats to protected areas, how these threats change and impact protected area management in each region, and how protected areas respond to these changes; 2) to assess the effectiveness of the present protected area system in protecting natural resources in Thailand and evaluate consequences of protected area management; and 3) to analyze gaps in the protected area system and management and propose options based on conservation concepts that could be applied to protected area management in Thailand.

4.2 Effectiveness of Protected Areas: A Brief Review

Effectiveness evaluation is not a new topic in protected area management. IUCN initiated a project to assess effectiveness of protected areas in the 1980's (IUCN 1981). However, despite the increase in establishing protected areas in the 1990's, effectiveness has received less attention. Recently, as conflicts have arisen in many protected areas, effectiveness has gained attention once again (Kramer et al. 1997, Brandon et al. 1998, Anderson and James 2001, Chatty and Colchester 2002). Though many approaches have been proposed to evaluate effectiveness of protected area management (Ervin 2000, 2001; Jones 2000; Alder et al. 2002; Hawthorn et al. 2002), the amount of research on the topic is still small compared to the number of existing protected areas all over the world. Also, because evaluations are difficult tasks, need a lot of data, and vary with condition, many protected areas have never been evaluated even though they were established over half a century ago.

Two areas considered in the evaluation of effectiveness of protected areas are the system and management (Hockings et al. 2002). Most evaluations are related to management (Albers and Grinspoon 1997, Good et al. 1998, Hershman et al. 1999, Bruner et al. 2001b), although system effectiveness has been tested in some areas in the last decade (Khan et al. 1997, Jaffre et al. 1998, Liu et al. 2001, Pressey and Taffs 2001b, Pressey et al. 2002). For protected area evaluation, there is still no consensus on the approach to evaluating protected areas, despite suggestions by WWF (2001) for terrestrial areas and Pomeroy et al. (2002) for marine areas. Approaches developed recently include interviews and rating systems for management evaluation, and use of indicators in system evaluation. Overviews of frameworks to evaluation of effectiveness are described by Hockings et al.

(2000) and Pomeroy et al. (2002), and approaches are reviewed in Hockings (2000).

Most evaluations of management effectiveness use a qualitative approach and typically found significant problems that may change through time. Such evaluations are typically conducted at a point in time. When applying the findings, in some cases areas need to be reevaluated as conditions surrounding protected areas change.

To measure effectiveness, many indicators have been used in evaluation of a protected area system, such as an increase in numbers and areas of reserves, representativeness, efficiency, vulnerability, density of organisms, harvest rate before and after setting up a reserve, and rate of fragmentation and habitat loss (Pressey and Taffs 2001b, Liu et al. 2001, Jepson et al. 2002). For evaluating management effectiveness, various indicators are used, including threats, legislation, policy, and resources input (Hockings et al. 2000, Brunner et al. 2001b). The choice of indicators used in the evaluation depends on aspects of system or management to be measured, data available, and methods. There is no standard for indicators used in evaluation of efficacy though some indicators suggested by Hockings et al. (2000) have recently been applied in different areas (Hockings et al. 2002). The lack of data and key indicators are still major obstacles, especially in developing countries.

4.3 Effectiveness of Protected Areas in Thailand: A Brief Review

The Thai government, through the Royal Forestry Department, has established protected areas to preserve natural resources in the country since 1960 (RFD 1994, 1996b). Because of limited resources and high pressures of land use and resource extraction resulting from population growth and use of natural resources for economic development, the government has faced resistance to setting up new areas in recent years. Though the RFD has succeeded in increasing protected units and areas in the last four decades, the reality is that the rate of destruction has been higher than the rate of establishment of areas for protection. Large areas are rarely set up, instead, small, fragmented areas generally are declared. Given this scenario, it is inevitable that conflicts in land use have increased with increasing numbers of protected units since available lands are fewer and demands on the lands from governmental organizations, forestry department, and the public have been increased.

Effectiveness of protected area management in Thailand has become a central issue in natural resources management in the last two decades. Many areas of management by government have been perceived negatively and have been questionable from the public because of insufficient public participation, corruption, lack of public relations, ineffectiveness in setting up and managing protected areas, political instability, and other factors. Though protected areas play crucial roles in protecting natural resources, provide ecological services and security, and generate significant raw material for subsistence of local people and economic development of the country, protected areas are still viewed as opponents to development, land use, and resources extraction. Given this, an evaluation of effectiveness of the protected area systems and management is necessary and may provide some answers to the public and help improve protected area management.

Besides the reviews and assessment of the protected area system and management mentioned earlier, no evaluation of effectiveness of protected areas system and management has been conducted for the whole country. Though there have been some attempts to improve the effectiveness of managers through training courses in the RFD, there has been a lack of evaluation of the efficacy of these attempts. Also, most valuation done in the past focused on identifying issues and suggesting solutions on a case-by-case basis over short time frames. Despite the fact that there have been some attempts at the Department of Forestry Graduate School at Kasetsart University to assess the efficiency of protected areas having master plans in helping in protected areas management (e.g., Wongwathana 1995), more work is needed to implement this idea on the ground.

4.4 Methods

4.4.1 Survey Methods

My evaluation of effectiveness of protected areas in Thailand is based on a multi-method approach (Figure 4) consisting of mail surveys, site visits and observations, and interviewing focus groups (Egan et al. 1995, Shindler and Wright 2000). This approach is useful when some answers from mail surveys are not clearly identified and to gain insightful information that would be missed when using only one method.

Questionnaires and interview guides were developed based on a review of previous surveys conducted in other countries, assessment of research literature, discussions with experts, and the key research questions (see Chapter 1 section 1.2) (Hockings 1997, 1998; Dudley et al. 1999a, 1999b; Hockings et al. 2000). To minimize questionnaire bias, experts in biological and social sciences at Oregon State University and Kasetsart University (Thailand) reviewed drafts of the questionnaires (Appendix 2). Questionnaires were sent to staff of the National Park and Wildlife Conservation Divisions. Because there is no general category of protected areas in Thailand (see Chapter 3 for the discussion), I limited the survey to heads of national parks and heads of wildlife sanctuaries. Of 190 protected units, 97 (51%) responded. Follow-up processes (e.g., sending more questionnaires, telephone call) were also conducted. However, it was impossible to get all the

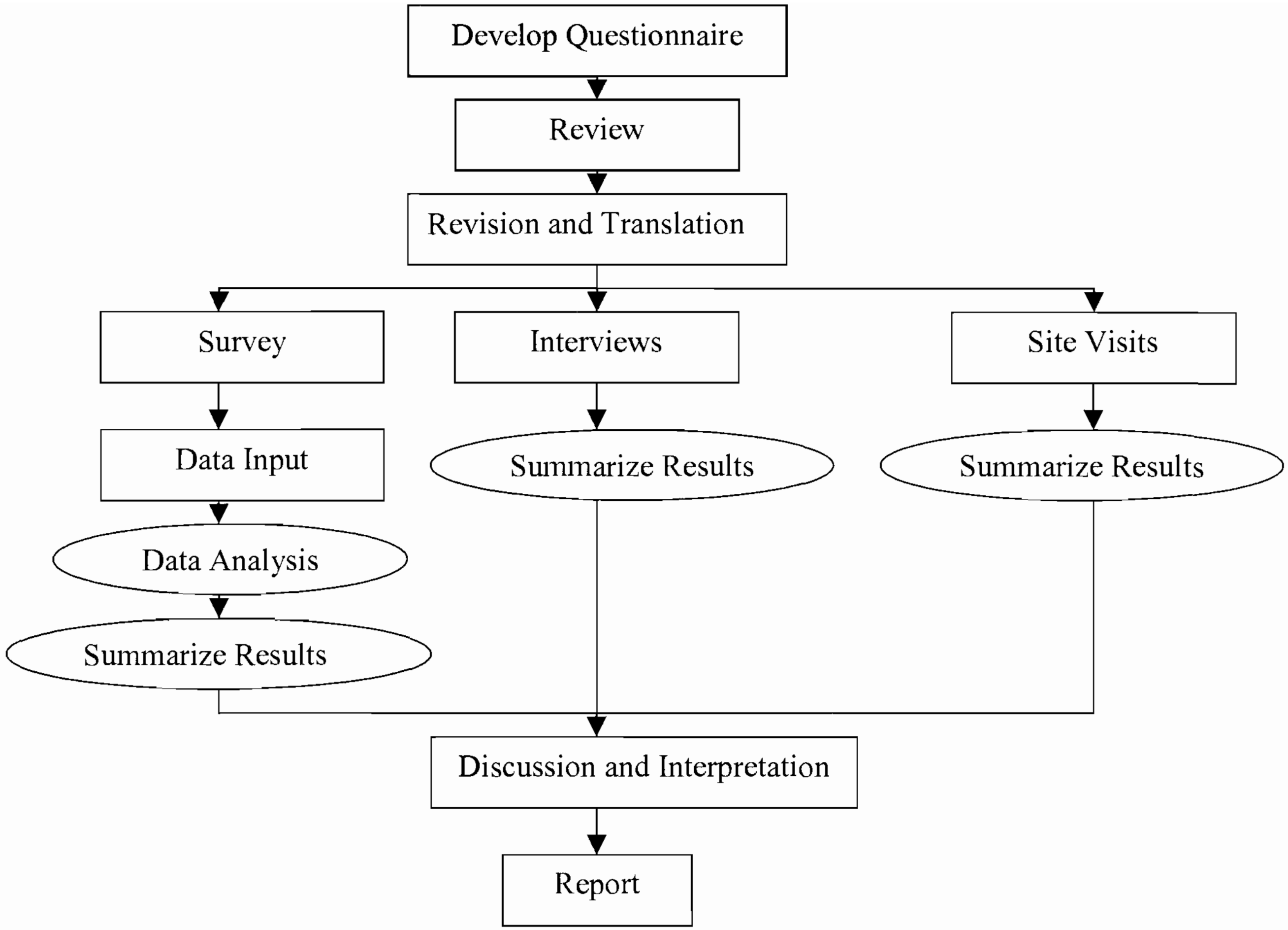

Figure 4. Research methodology flowchart.

questionnaires completed within the time constraints of the research; this was due largely to poor communication systems with some protected areas.

Site visits were conducted in northern, western, and eastern Thailand to uncover potential issues (both inside and outside protected areas). To verify management problems based on the interviews with staff of the RFD and heads of villages, I selectively visited study areas based on background information, expert opinions from the staff of RFD, and the findings from the questionnaires. Using these resources, I selectively visited protected areas that had a high degree of threat from human activities, were fragmented or isolated, were in special management categories, or were particularly significant to conservation in Thailand. Because issues often differed in many protected areas to another and because of limits of time and budget, I only accessed to four areas: Nam Tok Phrew National Park, Khao Soi Dow Wildlife Sanctuary, Mae Tuen Wildlife Sanctuary, and Lan Sang National Park.

To gain insight on past, present, and future approaches to problem solving in natural resource management, I interviewed 21 senior staff, directors, and foresters who have been working in protected areas over the last three decades. I also had discussions with experts who are teaching topics related to conservation and natural resources in universities (Appendix 3). These individuals represent people who used to or are currently working in the protected areas, or are conducting research related to the protected areas.

4.4.2 Data Sources

My evaluation relies on several sources of information. Primary data used in this chapter were surveys of the heads of national parks and wildlife sanctuaries, site visits, and discussions with the target groups mentioned above. To gain in-depth information and to review significant, uncovered problems, I included information from selected site visits where I met with the heads and staff of protected units who work on the grounds. To gain more insight into sensitive issues, I also used information from discussions with the heads of the villages and local people who benefit from protected areas.

Secondary data were collected from various divisions in the RFD and various government sources outside the RFD (Appendix 4). Data on protected areas (e.g., biological data, park boundaries, manpower, planning and management records) were gathered from records and documents of the RFD. Other information related to protected area management, such as development projects and administrative, cultural, economical, and societal data were gathered from documents published by other governmental organizations (e.g., Ministry of Agriculture and Cooperatives, National Research Council, NGOs, FAO, WWF, IUCN, universities and public libraries, and general public and local sources (e.g., villagers, communities). Biological references and documents were also gathered, but some of this secondary data was outdated. Though not updated in some areas, this was the best data that were available.

4.4.3 Data Analysis

Data gathered from background information, mail surveys, site visits, and interviews were analyzed using a variety of quantitative and qualitative approaches. Data about threats from closed-end questions in mail surveys were processed in SPSS version 11 to identify threats in different categories and regions. From these data I also investigated the level of impacts from threats in each category by using rating approach at 3 scales (L=low, M = Moderate, H=High) from 4 scales of questions (see Appendix 2, pages 222-223). Responses of "4" were assigned a rating of "L," responses of "3" were assigned a rating of "M," and responses of "1" and "2" were assigned a rating of "H." Analysis of threats was conducted for all data combined for national parks and wildlife sanctuaries separately, and by region designated by National Park and Wildlife Conservation Divisions (PWPCD 2003). Data about system effectiveness and management effectiveness from closed-end questions were used to build the model response of effectiveness at 3 scales (H=effective, M=Moderate, L= Ineffective) from 5 scales of questions (see Appendix 2, pages 224 and 227). Responses of "4" and "5" were assigned a rating of "L," responses of "3" were assigned a rating of "M," and responses of "1" and "2" were assigned a rating of "H." To estimate overall effectiveness, system effectiveness, and management effectiveness, I used S-Plus version 6.1 to calculate correlations (r) among responses to questions. Responses correlated questions at

$r \geq 0.5$ were combined into a single index by computing the mean response to the questions combined. In cases where responses were correlated among more than one question, I grouped questions into categories based on logical combinations given subject-matter consideration. Questions or indices were then grouped by categories representing key elements of effectiveness (see Table 5). I weighted each question or index equally to build an index of effectiveness for each key element of effectiveness using the mean values calculated from the original response in 5 levels. The mean of values for key elements was then calculated as an over all index of effectiveness for system effectiveness and management effectiveness. The mean of overall indices for system effectiveness and management effectiveness was used as estimate of overall effectiveness. By applying these categories into three levels of scale: L = Low = 3.51–5.00; M = Moderate = 2.51-3.50; H = High = 1-2.50, I calculated the indices for each key element, system effectiveness, management effectiveness, and overall effectiveness.

To help explain the reasons for and context behind the data generated by the objective survey questions, I utilized the findings from open-end questions, site visits, and discussions with experts.

4.5 Results

4.5.1 Background Information

The findings from the survey reveal that public land (i.e., national forests) was the most common (97.9%) land use category for a location before the protected area was designated. The government sector played a significant role (88.7%) in proposing the designation of protected areas. The most common reason given for establishing protected areas was to protect natural resources (82.5%), with some areas citing recreational goals. Ecological services, representativeness (e.g., wildlife species habitats), and significance of species (e.g., rarity) were major criteria (81%) used in setting up protected areas; using a survey as well as existing records is an approach to implementing these criteria. Most protected areas in this study have never changed in size or been re-categorized.

4.5.2 Threats

(1) Types of threats to protected areas. The analysis of the survey reveals significant threats to protected areas in three aspects (Table 1): overall threats throughout the country, threats to national parks and wildlife sanctuary, and regional threats.

- Overall threats throughout the country. Major threats to protected areas are illegal hunting (92.8%), illegal logging (90.7%), land conversion for agriculture

Table 1. Threats to protected areas (Percentage of threats calculated from responses in each category: O = Overall, 97 responses; NP = National Park, 69 responses; WS = Wildlife Sanctuary, 28 responses; N = North, 33 responses; NE = Northeast, 16 responses; C = Central, 17 responses; S = South, 31 responses).

Threats	O	NP	WS	N	NE	C	S
1. Illegal hunting	92.8	89.9	100	100	100	94.1	80.6
2. Illegal logging	90.7	89.9	92.9	97.0	100	82.4	83.9
3. Land conversion for agriculture	89.7	88.4	92.9	100	87.5	88.2	80.6
4. Extraction of non-timber forest product (i.e., collecting mushroom, fodders, honey)	88.7	85.5	96.4	100	93.8	88.2	74.2
5. Population density (radius 10 km^2)	85.6	84.1	89.3	90.9	93.8	64.7	87.1
6. Recreation activities	79.4	88.4	57.1	69.7	75.5	88.2	87.1
7. Disturbance (i.e., fire)	76.3	71.0	89.3	100	93.8	88.2	35.5
8. Access (i.e., trails, roads)	76.3	71.0	89.3	93.9	81.3	76.5	54.8
9. Collecting fuel wood/ charcoal making	72.2	72.5	71.4	87.9	87.5	58.8	54.8
10. Grazing/livestock	64.9	63.8	67.9	81.8	87.5	58.8	38.7
11. Land encroachment	52.6	53.6	50	57.6	50	52.9	48.4
12. Sewage	52.6	55.1	46.4	57.6	56.3	52.9	45.2
13. Pesticide	50.5	42.0	71.4	72.7	37.5	47.1	35.5
14. Invasive/exotic species	30.9	33.3	25.0	30.3	43.8	23.5	29.0
15. Government development projects (i.e., dams)	29.9	27.5	35.7	30.3	50.0	17.6	25.8
16. Noise	24.7	26.1	21.4	18.2	43.8	17.6	25.8
17. Disease	17.5	14.5	25.0	21.2	25.0	11.8	12.9
18. Heavy metal	12.4	14.5	7.1	9.1	18.8	17.6	9.7
19. Urbanization (i.e., resort, hotel)	8.2	10.1	3.6	6.1	6.3	17.6	6.5
20. Other (e.g., coral reef destruction, boundary	8.2	7.2	10.7	6.1	0.00	5.9	16.1

Table 1. (Continued).

problems with other countries)							
21. Mining	7.2	7.2	7.1	6.1	6.3	11.8	6.5
22. Acid rain	6.2	5.8	7.1	9.1	6.3	0.00	6.5
23. Land development projects (i.e., golf courses)	4.1	5.8	0.00	3.0	12.5	0.00	3.2

(89.7%), extraction of non-timber forest products (88.7%), and pressures from populations living around the protected units (85.6%). Other threats that have great impacts on the protection of forest areas in Thailand are recreation activities (79.4%), roads (76.3%), and fire (76.3%). Recreationists now impact protected areas, especially in protected areas located close to large cities, since the government set up a policy to promote tourism. Ecological impacts from building roads through the forest is another threat that has long been ignored by the government. Also, though forest fire protection has gained support from the government, the work done is still far less than the amount of fire caused by humans. Most protected areas face pressures from human activities in a 10-kilometer radius beyond their borders.

- Threats to national parks and wildlife sanctuaries. Illegal hunting and logging occur in most of national parks (89.9%) and wildlife sanctuaries (100%). Since the regulations of national parks allows people to have recreation activities, impacts from recreation are found mainly in national parks (89.9%) whereas recreation impacts found in wildlife sanctuaries were lower (57.1%). Impacts of pesticides (WS = 71.4%, NP = 42%) also appear to vary with category. Otherwise threats to wildlife sanctuaries and national parks were similar.

- Regional threats. Threats from human activities to protected areas in different regions have patterns similar to those for overall threats and threats to national parks and wildlife sanctuaries. Illegal hunting and logging are major threats in all regions. Ecological impacts from high population density are problematic not only on the mainland (e.g., 93.8% in the northeast) but also on the islands (e.g., 74.2% in the south). In the south, which is peninsular and humid most of the year, recreational activities (such as scuba diving) are major threats (87.1%) in sensitive sites in many marine protected areas. Recreational impacts are somewhat less in other regions. In contrast, impacts from forest fires (35.5%) are few in the south compared to other regions such as in the north (100%), northeast (88%), and central (88.2%) regions. Similar trends are seen for impacts from roads and trails in the north (93.9%), northeast (81.3%), central (76.5%), and south (54.8%). Interestingly, protected areas in the northeast, the most popular region, are more likely to have received impacts from government development projects and noise than in the central region, where protected areas are located as a complex in the west of the region (see Figure 3, Chapter3).

(2) Degrees and scales of impacts. Overall impacts from the threats in all protected areas are high, but spatial and temporal scales of impacts are low. Moreover, the resistance of protected areas to threats is high, but resilience of areas is low (Table 2). Pressures from populations within a radius of 10 kilometers are moderate, but spatial and temporal scales are high, whereas resistance and resilience of protected areas are moderate. In addition, degree of impacts from forest fires both spatial and temporal scales of impact are high, but resistance and resilience of areas are moderate. Impacts and spatial scale of impact from illegal

Table 2. Threats and scales of impacts to protected areas (O = Overall threat form 97 responses; DI = Degree of Impacts: H = High, M= Moderate, L = Low; SIS = Scale of Impacts (spatial): H= High (> 2 km^2), M = Moderate = (1-2 km^2), Low (<1 km^2); SIT = Scale of Impacts (temporal): H= Long (>14 days), M= Moderate (7-14 days), L= Low (<7 days); R = Resistance: H = High, M= Moderate, L = Low; RS = Resilience: H = High, M= Moderate, L = Low).

Threats	O (Percent)	DI (Mean)	SIS (Mean)	SIT (Mean)	R (Mean)	RS (Mean)
1. Illegal hunting	92.8	L (3.1)	L (3.0)	H (2.6)	L (2.9)	L (3.1)
2. Illegal logging	90.7	L (3.2)	L (3.4)	H (2.5)	H (2.6)	M (2.8)
3. Land conversion for agriculture	89.7	L (3.1)	L (3.2)	H (1.9)	M (2.7)	M (2.9)
4. Extraction of non-timber forest product (i.e., collecting mushroom, fodders, honey)	88.7	L (3.3)	L (3.2)	H (2.7)	H (2.6)	H (2.4)
5. Population density (radius 10 km^2)	85.6	M (2.7)	H (2.7)	H (1.8)	M (3.0)	M (3.1)
6. Recreation activities	79.4	L (3.3)	L (3.3)	L (2.7)	L (3.0)	L (2.9)
7. Disturbance (i.e., fire)	76.3	H (2.7)	H (2.6)	H (2.2)	M (3.0)	M (2.8)
8. Access (i.e., trails, roads)	76.3	L (3.2)	L (2.9)	H (2.3)	H (2.7)	H (2.8)
9. Collecting fuel wood/ charcoal making	72.2	L (3.5)	L (3.6)	L (2.8)	H (2.6)	H (2.6)
10. Grazing/livestock	64.9	L (3.2)	L (3.0)	H (2.3)	H (2.5)	H (2.6)
11. Land encroachment	52.6	L (3.4)	L (3.3)	L (2.1)	L (2.9)	L (3.0)
12. Sewage	52.6	L (3.3)	L (3.4)	L (2.8)	H (2.8)	H (2.9)
13. Pesticide	50.5	L (3.2)	L (3.3)	L (2.8)	L (2.7)	L (2.7)
14. Invasive/exotic species	30.9	L (3.7)	L (3.6)	H (2.2)	H (2.5)	H (2.2)
15. Government development projects (i.e., dams)	29.9	L (3.1)	L (3.0)	H (2.4)	H (2.6)	L (3.2)
16. Noise	24.7	L (3.5)	L (3.7)	L (3.8)	L (3.1)	L (2.5)

Table 2. (Continued).

17. Disease	17.5	L (3.6)	M (3.9)	M (3.2)	M (2.6)	H (2.5)
18. Heavy metal	12.4	L (3.3)	L (3.5)	M (3.5)	M (3.2)	H (2.6)
19. Urbanization (i.e., resort, hotel)	8.2	L (2.9)	M (3.4)	H (2.0)	H (3.5)	L (3.0)
20. Other (e.g., coral reef destruction, boundary problems with other countries)	8.2	M (2.3)	H (2.2)	H (1.25)	M (3.6)	M (3.8)
21. Mining	7.2	L (3.0)	M (2.5)	H (1.5)	H (3.5)	H (4.0)
22. Acid rain	6.2	M (3)	L (0)	H (1)	H (1)	L (1)
23. Land development projects (i.e., golf courses)	4.1	H (2.3)	H (2.5)	H (2.5)	M (3.5)	M (3.5)
Overall		H (3.1)	L (3.0)	L (2.4)	H (2.8)	L (2.8)

hunting and illegal hunting are low since most of national parks and wildlife sanctuaries are considered well protected, but temporally impacts are long. However, resistance of the areas to illegal hunting is low indicating the vulnerability of wildlife species in most protected areas, whereas resistance of the areas to illegal logging is high.

(3) Findings from opened-ended questions, interviews and site visits. The findings from opened-end questions and personal observations and discussions during site visits also indicate land encroachment for agricultural purposes, illegal logging (including harvesting and exporting forest products), illegal hunting, encroachment for other purposes (e.g., shrimp ponds, commercial purposes, human habitation, and mining), and shifting cultivation were major threats to protected areas before they were set up as protected units. Major impacts from these threats are degraded forest health and ecosystem services, deforestation, land conversion (e.g., from forest to agricultural or development land), and a decrease in size of the protected areas, resulting in decreasing wildlife habitat and species loss. The responses to these impacts from protected areas include the degradation of ecosystem health, erosion and sedimentation, habitat degradation and loss, impacts to watersheds (e.g., low water quality and channel diversion), and decreases in the number of plant species. Major approaches that managers use when responding to these impacts are protection (i.e., set up new guard stations, increase patrolling, fire protection), public relations, education programs, cooperation with other

departments and local people, reforestation, and using cabinet resolutions resolve conflicts.

The findings from opened-ended questions and interviews with experts also suggest that major future threats to protected areas include population growth, increased land encroachment, impacts from tourists and development, and illegal logging and hunting. Other threats that also have negative impacts on protected areas are local people (e.g., threats from landless people, boundary and land use conflicts), forest fires, collection of non-timber forest products, and government policies.

4.5.3 Effectiveness of Protected Area System and Management

(1) Protected area systems. Responses to closed-ended questions reveal that of 22 questions concerning that protected area system, modal response to 17 questions classified system characteristics as effective, and five were classified as moderate effectiveness. No question had a modal response of ineffective (Table 3). In addition, the findings from open-ended questions, discussions, and site visits confirm that the majority of the heads of protected areas feel that present systems effectively protect natural resources. Findings from open-ended questions also suggest that criteria used to judge the effectiveness of the system are the decrease in the rate of encroachment and deforestation compared to the past, the existence of plants, animals, and key ecosystems in the areas, the status of biodiversity in the

Table 3. Modal and mean responses to questions pertaining to system effectiveness (Scales of effectiveness: H = Effective, M = Moderate, L = Ineffective).

System Effectiveness	Modal Response	Mean	Standard Deviation
1. Protected areas function.	H	2.2	0.9
2. Method(s) used to set up the protected areas.	M	2.8	0.8
3. Criteria used to set up the protected areas.	H	2.5	0.8
4. Reasons used to set up the protected areas.	H	2.0	0.7
5. Locations of the protected areas.	H	2.3	0.8
6. Sizes of the protected areas.	H	2.5	0.9
7. Number of protected areas.	M	2.7	1.2
8. Percentage of the protected areas compared to unprotected areas.	H	2.9	1.4
9. Network(s) of protected areas.	M	3.0	1.3
10. Representativeness of plant species contained in the protected areas.	H	2.2	1.2
11. Representativeness of animal species contained in the protected areas.	H	2.4	1.1
12. Representativeness of geological features contained in the protected areas.	H	2.3	1.1
13. Species richness (number of species) contained in the protected areas.	H	2.4	1.1
14. Number of rare species contained in the protected areas.	M	2.7	1.2
15. Number of threatened species contained in the protected areas.	M	3.0	1.2
16. Number of endangered species contained in the protected areas.	H	3.2	1.5
17. Number of endemic species contained in the protected areas.	H	3.1	1.5
18. Performance of the protected areas in protecting natural resources from threats.	H	2.1	0.9
19. Performance of the protected areas in recovering after a disturbance.	H	2.7	1.0
20. Protected areas in providing service to society.	H	2.5	0.8
21. Protected areas in providing economical benefits to people in this country.	H	2.7	1.1
22. Protected area system in Thailand at the international level.	H	2.6	1.1

protected unit, and the efficacy of protection. On the other hand, some of the heads of protected units felt that an inadequate amount of government resources invested in the system is a major cause of the protected area system's ineffectiveness in protecting the plants, ecosystems, wildlife, and fungi that they believed to be the most important natural resources in protected areas.

Although the majority of the heads of protected units (68%) felt that protected areas are large enough to allow the viability of preserved species, most (75 %) felt that protected areas should be expanded, with the major reasons being to preserve and increase biodiversity, to support ecosystem health and wildlife species, to protect sensitive areas from encroachment and destruction, to add representativeness and include other remnant key areas under protection, and to provide recreational opportunities. Though the majority (63%) did not feel that protected areas should be decreased in size, some (34%) felt that decreasing size would be a good way to resolve land use conflicts in areas that were occupied by local people, a community, village, or city before being declared as protected areas, or in areas along the boundary between unprotected and protected areas.

Although most of the heads of protected areas (88%) felt that protected areas should not be re-classified, some suggested changes, with the major reason being the appropriateness of the category to the areas. For instance, they argued areas having tourist spots should be designed as national parks instead of wildlife sanctuaries, or some areas should be wildlife sanctuaries instead of national parks because those areas contain rare species. The findings from this research reveal that most protected areas contain species from CITES, or IUCN species lists. Also, many protected areas have buffer zones (47%) and corridors (66%). Of 97 protected areas, 67 (69%) have connectivity (e.g., located next to other protected areas or connected via corridors). However, a large number of protected areas (31%) are still relatively isolated. For protected areas having connectivity, 66% are connected by national parks, 62% by wildlife sanctuaries, and 32% by other types of forests such as national forests, non-hunting areas, mangrove national forest, and transboundary between countries. Also, 29 protected areas (43%) are connected by more than one category (e.g., national parks and wildlife sanctuary). For protected areas having connectivity with national parks, 66% are connected with one national park, 30% with two national parks. For protected areas having connectivity with wildlife sanctuaries, 71% are connected with one wildlife sanctuary, and 29% with two wildlife sanctuaries.

In short, my study suggests that though the system of protected area is rated as effective, the protected area systems need to be improved to ensure the efficiency of protection. For example, protected area systems need to be re-categorized. In some areas, protected areas should be considered for expansion and building up of connectivity and buffer. To accomplish this goal, suggestions are presented in a later section.

(2) Protected area management. Responses to closed-ended questions concerning management of protected areas indicate that of 22 questions, modal response to 20 were questions classified protected area management as moderately effective. Only two questions (performance of managers in administering protected areas and success of work in protecting natural resources) had a modal response of effective (Table 4). The findings from open-ended questions, discussions, and site visits revealed that in the past the most difficult problems were land encroachment for agricultural purposes (including shifting cultivation and encroachment of watershed areas by hill tribes), land encroachment for other purposes, impacts from population growth, illegal logging, conflicts with people who live along the boundary, and lack of resource support. Many problems still exist, such as land encroachment both for agriculture and other purposes and impacts from population growth. My findings also project that in the future the biggest problem will be resource shortages due to population growth, land encroachment, government policy, unstable politics, ineffective management, inadequacy of resources in protected area management, and a lack of awareness of people in the society to conserve natural resources.

The findings from open-end questions, discussions, and site visits also disclose that major causes that contribute to ineffective protected area management come from the staff of the RFD, including lack of ambition, excitement, knowledge, experience, and attention, inefficiency, administrative failures,

Table 4. Modal and mean responses to questions pertaining to management effectiveness (Scales of effectiveness: H = Effective, M = Moderate, L = Ineffective).

Management Effectiveness	Modal Response	Mean	Standard Deviation
1. Effectiveness of protected area management.	M	2.7	0.9
2. Performance of the Royal Forest Department in overseeing protected areas.	M	2.8	1.0
3. Performance of managers in administering protected areas.	H	2.6	0.9
4. Performance of the Royal Forest Department in public relation projects.	M	3.1	1.0
5. Performance of managers in communicating with the public.	M	2.8	0.9
6. Performance of the Royal Forest Department in supporting education projects.	M	3.2	1.0
7. Performance of managers working in education projects.	M	3.1	1.0
8. Performance of the Royal Forest Department in providing the public a mechanism to access the information.	M	3.1	1.0
9. Performance of the managers in providing the public a mechanism to access the information related to the protected units.	M	2.7	1.0
10. An opportunity provided by the Royal Forest Department for the public to participate in natural resource management.	M	3.3	1.1
11. Performance of the Royal Forest Department in allowing the public to access the protected areas.	M	2.8	1.0
12. Performance of the managers in allowing the public to access the protected areas.	M	2.8	0.9
13. Performance of the Royal Forest Department in solving conflicts in the protected areas.	M	2.9	1.2
14. Performance of the managers in solving problems related to protected areas management.	M	2.7	0.9
15. Performance of the staff of the Royal Forest Department in working with other			

Table 4. (Continued).

governmental organizations.	M	2.6	0.9
16. Performance of the staff of the Royal Forest Department in working with international organizations.	M	2.7	0.9
17. Performance of managers in working with the staff of NGOs.	M	3.1	0.9
18. Performance of the staff the Royal Forest Department in working with local people.	M	3.0	0.9
19. Performance of the staff the Royal Forest Department in working with the researchers from outside the department.	M	3.1	1.1
20. The level of success of work managed by the staff of the Royal Forest Department in protecting natural resources.	H	2.5	1.0
21. The level of success of work managed by the staff of the Royal Forest Department to meet the needs of the people in the society.	M	3.1	1.0
22. The strength of the regulations set up by the Thai government to protect biodiversity under international agreements (i.e., CITES, Convention Biodiversity).	M	3.0	1.4

lack of essential projects, inadequacy of resource investment, policy conflicts among the government sectors, lack of cooperation with many groups of people in the society and between local people and the staff of the government, and weak public relations from the RFD. Major consequences from management ineffectiveness are degraded ecosystem health and services, loss of key species, increased deforestation inside, around, and outside protected areas, increased vulnerability of protected areas, and a decrease in the size of protected areas. Many management techniques have been suggested to improve management effectiveness of protected areas are to increase participation from local people and the public, including use of public relations, improving staff quality and transparency, human development, improve administration, and increasing resources to support management strategy.

(3) Index of protected area effectiveness. Using the approach described in 4.4.3, correlation analysis for protected area system revealed 17 correlations with $r \geq 0.5$ among 22 questions. Significant correlations are locations and size of protected areas ($r = 0.609$), criteria and reasons used to set up the protected area ($r = 0.561$), methods used to set up and networks of protected areas ($r = 0.511$). Number of species (e.g., rare, threatened, endangered) and representativeness (e.g., plants, animal, geological features) are two groups of questions also correlated to each other within the groups. For protected area management, 45 correlations with

$r \geq 0.5$ were found among 22 questions. People participation is correlated with several other questions, including RFD allowing the public to access protected areas (r = 0. 632), managers allowing the public to access protected areas (r = 0.581), solving conflicts by the RFD (r = 0.578), RFD'managers working with NGOs (r = 0.574), RFD allowing public access information (r = 0.540), performance of managers working with local people (r = 0.536), mangers allowing the public to access information of protected units (r = 0.524), performance of the RFD in public relation projects (r = 0.519), and RFD's staff working with researchers from outside the department (r = 0.503).

Based on indices of effectiveness (Table 5), protected area functions and performance of protected areas are high, whereas the other key elements of system effectiveness groups are rated moderate. However, index for overall system of protected areas is rated high. For the indices of effectiveness of protected areas management, each of nine key elements is rated as moderate, as is the overall index for management. When evaluating the overall index of effectiveness of protected areas using system and management ratings, the results suggest an overall rating at moderate.

Table 5. Indices of protected area effectiveness (Scale: L =Low: 3.51 –5.00; M = Moderate = 2.51-3.50; H = High = 1-2.50).

Index Effectiveness	Modal Response	Mean
I. System effectiveness		
Protected area functions	H	2.2
Protected area design and characteristics	M	2.6
Representativeness and key species contained	M	2.6
Performance of protected areas in protecting and recovering from disturbance	H	2.3
Roles of protected areas in society and at the international level	M	2.6
Overall index of system effectiveness	H	2.5
II. Management effectiveness		
Overseeing and administering protected areas	M	2.7
Public relation	M	2.9
Education	M	3.2
Public access information	M	2.9
People participation	M	3.3
Public access protected area	M	2.9
Conflict resolution	M	2.8
Cooperation work	M	2.8
Regulations under international agreement to protect protected areas	M	2.9
Overall index of management effectiveness	M	2.9
Overall effectiveness	M	2.7

4.6 Issues and Gaps in Protected Area Management in Thailand

I identified sixteen significant issues in protected area system and management in Thailand (Table 6) from my review of protected areas in Thailand (Chapter 3), the survey (this chapter), and discussions with experts (this chapter and Appendix 3). Key issues in protected area systems are size, location, prioritization of resources and areas to protect, and recategorization of existing protected areas. Key conservation priorities should include ensuring that existing protected areas are effective and establishing additional protected areas in key areas. Existing protected areas are isolated (Figure 3, Chapter 3), faced with high threats, not large enough to provide habitat for keystone species, and are not located in some areas containing key representations. More importantly, designating protected areas in an inappropriate category (such as a national park instead of a wildlife sanctuary) potentially can create negative impacts to fragile plants and animals in the protected area, since the size and number of protected areas do not guarantee the continued existence of all species. Protecting key forests should be the first priority, followed by setting up new areas, expanding existing areas, and building up connectivity and decreasing pressures from threats from local to national scales.

The findings from open-ended questions, discussions, and site visits revealed key issues in protected areas management include lack of management

Table 6. Gaps found in protected area management in Thailand.

Problems (gaps)	Details	How to improve/bridge the gaps	Remark/ Reference
I. PA System 1. PA design and selection.			- Margules and Austin (1991); Margules et al. (1991, 1994); Agardy (1994); Noss (1996); Wright (1996); Pigram and Sundell (1997); Kremen et al. (1999, 2001); Soulé and Terborgh (1999); Roberts and Hawkins (2000).
- Size.	- Individual or small reserves (in some areas) instead of large areas or reserve networks.	- Establish large reserves or reserve networks, expand individual reserves, and build up networks.	
- Location.	- Unprotected key species or units, or lack of representations in some areas.	- Build up the database for all PAs and review gaps in protected area system.	- Consider representativeness and gap analysis. - Use GIS to help expand existing PAs.

Table 6. (Continued).

	-Fragmented/isolated reserves.	-If fragmented by category, consider combining reserves with others in the same category or re-categorization.	- No general rule or solutions, but overall guidelines may be implemented on a case by case basis.
		-If fragmented by reserve units, consider building connectivity.	-Buffer zones may slow down fragmentation in some areas.
		- If reserves become islands due to fragmentation, create buffers for terrestrial islands, or set up no-take zones for marine protected areas.	-In national parks, zoning cannot guarantee the impacts from recreation activities (Day and Roff 2000).
	- Land use conflicts in designing new protected areas.	- Set up new reserves based on ecological criteria, while achieving social and political acceptance (if possible).	- The result may be distorted by pressure from political and social needs. Key species and habitats should not be compromised.
	-Boundary conflict resulting from previous setting of	- Use conflict resolution.	- Stakeholders should consider benefits of the

Table 6. (Continued).

	reserves, reclassification, or expansion approaches.		country, based on sound ecology. If necessary, new encroachers should be relocated to less sensitive areas and by receive appropriate compensation from the government. - Criteria should be based on ecological significance and risk from threats. Societal acceptance, political support, and economic feasibility should be minor concerns (Kremen et al. 2001; Roberts,et al. 2003a, 2003b).
2. PA prioritization.	- Lack ecological criteria to prioritize areas in establishing new reserves and expansion or re-categorization of existing reserves.	-Set up criteria based on the potential of significant areas, in combination with system and management objectives.	- Usher and Margules (1981), Bolton and Specht (1983), Smith and Theberge (1986), Pressey et al. (1993), Caldecott et al. (1994), Department of Conservation (1994), Johnson (1995), McNeely (1996), Green et al. (1997), Williams (1998).

Table 6. (Continued).

	- Priorities have been set up for political & economic reasons.	-Review and re-categorize based on ecological attributes. One division should take responsibility for setting up national criteria.	- Conduct when resources are sufficient.
	- Lack of standard criteria to prioritize resources for protected areas.	- Set up criteria based on ecological concerns, potential of threats, size of area, and adequacy of resources.	- Dinerstein and Wikramanayake (1992).
3. PA categories/ Reclassification.	- Inappropriate categories in targeted areas or different PA categories in the same area.	-Reclassify on an ecological basis.	- Implement when resources are available. Categories should be made publicly.
	-Some protected areas were classified to inappropriate categories. For example, the area that contains rare species and significant wildlife habitats should not be declared as a national park but as a wildlife sanctuary.	- If reserves located adjacent to each other are the same category, should consider combining with the same area.	- Should be cautious with reclassifying from wildlife sanctuary to national park because it means decreasing the level of protection by increasing human impacts. - Related work: Kanjana (2000), Prayurasiddhi et al. (1999).

Table 6. (Continued).

	- Isolated/individual PA in the same category.	- Connect reserve in the same category into networks.	- No absolute answer. However, land negotiation should be based on an ecological standpoint. - Margules et al. (1991, 1994); Noss (1996), Wright (1996), Soulé and Terborgh (1999).
II. PA Management 1. Definition. 2. Legislation. 3. Policy.	- Different people define the concept of protected area in different ways. -Cabinet resolutions conflict with major laws and with other cabinet resolutions. -Lack of a national policy for protected areas.	-Clarify the definition and inform the public. -The RFD and the Prime Minister Office should make sure that there are no conflicts in creating new cabinet resolutions. -Create a national policy for protected areas.	-Definition should not be limited to laws but should be ecological meaningful. -PA national policy and national forest policy should rely on each other. - Park Canada (1999), NPS (2000), Fennell and Dowling

Table 6. (Continued).

			(2003).
4. Institution.	- The RFD is too large and lacks checks and balances.	-Group together tasks with the same responsibility. - Build up a check and balance system. - Establish oversight committees.	- New structure in 2003 (PWPCD 2003, MONRE 2003).
5. Management and protection.	-Some areas have weak protection, and natural resources are still in great danger.	- Increase protection by re-categorization, increase resources, set up new procedures for management. - Decrease pressures or threats and increase effectiveness of management.	- Use the appropriate category in accordance with the potential of the area. - Wells and Brandon (1992), IUCN (1994), Kelleher (1999), WCPA. (2000), Beltran (2000), Sandwith (2001), Worboys et (2001), Eagles and McCool (2002), Eagles et al. (2002), Bondrup-Nielsen et al. (2002).
6. Tools.	-Lack of tools.	- Apply existing tools based on existing data and increase the potential of the database.	- If data are not available, some kinds of tools (GIS, programming) may not be applicable.

Table 6. (Continued).

			- Scott et al. (1991a, 1991b, 1991c); Scott et al. (1993a, 1993b); Csuti et al. (1995); Scott et al. (1996); Jennings (2000).
7. Planning.	-Lack of a national system plan. - Reserves are plan individually or on a small scale.	-Set up the national system plan to be a guideline in protected area management (Chettamart 2001b). - Consider planning as a network or on a larger scale. - Plan beyond boundaries by including areas outside reserves.	- Goals may not be achieved if some aspects of the plan are not actually implemented. - Take care to not spend too many resources and time just for planning. - Need to consider how to include potential threats in areas in the planning process. - Should consider including impacts from invasive species and global warming into plans. - Noss et al. (1997), Davey (1998), Miller (1999), Margules and Pressey. (2000), Dudley and Pressey (2001), Eagles and McCool

Table 6. (Continued).

			(2002), Eagles et al. (2002), Groves et al. (2002), Groves (2003), Nelson et al. (2003), Fennell and Dowling (2003).
8. PA Evaluation.	- Few evaluations have been done. For the areas that were already evaluated, still need to inform the public.	- The RFD should support evaluation for most major key areas.	-Evaluations should be conducted when the RFD has sufficient resources or gain support form outside organization. - It is difficult to conduct if the RFD still has unclear frameworks and policies. - RFD (1998a, 1998b, 1999b); WCPA (1998).
9. PA Monitoring	-Lack of monitoring criteria and frameworks for protected areas.	- Set up a protocol and monitoring projects in every protected area.	- Silsbee and Peterson (1991), NPS (1995), Peterson et al. (1995).
10. Research and education	- Many areas in basic & applied ecology need to be researched.	- Research should examine applied and basic issues. - Applied research should be long-term ecological impacts from human activities around and	- One important area for protected areas management is conflict resolution.

Table 6. (Continued).

		inside protected areas. - Basic research related to forest ecology should be initiated and supported.	
11. Public involvement	- Conflicts between local people and the staff of the RFD. - Lack of public involvement in some areas, i.e., in the planning process, or management. - No implementation and evaluation.	- Use conflict resolutions if necessary. - Add public hearing in planning process. - Get public involved in co-management in buffer areas	- Clarify what people involvement means to the public and what level the public could participate and help the government protect biodiversity. - Wondolleck (1988), Fisher (1995), Borrini-Feyerbend (1996), Yaffee and Wondolleck (1997), Wondolleck and Yaffee (2000), Lewicki et al. (2003).
12. International agreements.	- The staff of the RFD lacks understanding international agreements. - The public lacks understanding international agreements.	- Increase understanding of the staff of the RFD through in-house publications and training projects. - Public education.	

efficiency, policy and planning, monitoring and evaluation procedures, lack of public involvement, and inadequate research and education. My findings indicate that many protected areas do not have adequate protection, as they lack government support and face threats and conflicts in land use with other governmental organizations and local people. Problems also relate to the lack of policy guidelines and planning implementation. Though GIS has been introduced to build databases in some areas, much work still needs to be done, including an evaluation of effectiveness and long term monitoring programs in protected areas. However, achieving this will be challenging as a good database is lacking. Conducting research on the ground is still quite difficult for managers who routinely face serious threats to protected units. Working with communities is one option, but it cannot solve the whole problem as long as land use conflicts still exist. More importantly, protected area management will continue to be difficult as long as the government is unstable, lacks the political will to protect natural resources, and encourages people to encroach forestlands through exportation policies. The problems become more complex with high uncertainty since people are still hungry, problems of land distribution still exist, the economy still relies on other countries, and less than ten percent of the people in the country control the economy, leading to a wide gap between rich and poor. Also, boundary and land use conflicts will be the largest and most difficult problems in this country as long as people encroach forestlands. Though boundary conflicts have been resolved in some areas, conflicts may occur again if lands outside reserves change ownership, stakeholders change, or populations continue to grow. As a result of changing dynamics, many of the solutions suggested in Table 6 may work one time but not in another, even in the same area with the same problems.

4.7 Discussion

4.7.1 Threats

Threats and degrees of impacts from threats to protected areas may change over time, but in general the types of threats encountered in the past have not changed substantially (Kunstadter et al. 1978, Ives et al. 1980, Kunstadter and Sabhasri 1986, Jintanugool 1992, RFD 1992, Prayurasiddhi 1997, Pattanavibool 1999). Many of these threats are prevalent in Southeast Asia (Thorsell 1985, Primack and Lovejoy 1995) and other tropical countries (Brown and Pearce 1994, Laurance and Bierregaard 1997, Robinson and Bennett 2000, Fimbel et al. 2001, Terborgh et al. 2002, Oldfield 2003). This study confirms that illegal activities and encroachment are still problems in Thailand's protected areas.

Impacts from high population density, access, and recreation are potential threats in national parks and wildlife sanctuaries, and are found across regions. To decrease pressures from these threats, attention should focus on limiting root causes by decreasing population growth, limiting migration of people from one protected area to another, not building new roads through protected areas, and limiting recreation in sensitive areas.

Disturbance and invasive species have increasingly become potential threats. Most fires in Thailand are caused by humans. There is no simple rule for stopping human-caused fires, even though public relations have been introduced, since the root causes are complex from social, political, and economic standpoints.

Illegal hunting was reported as a problem in every wildlife sanctuary surveyed. This reveals pressures from humans toward this protected category are widespread, and wildlife sanctuaries are considered to be the place to hunt wildlife species by many people.

Land conversion, illegal hunting and logging, disturbances, and extraction of non-timber forest product occur in many areas in northern Thailand (Table 1). Possible explanations are: this region is mountainous with a good climate, high population density in nearly urban areas, land conflicts among groups of people, increase in land prices resulting from development projects, and the tourism policy in the region. Protected areas in this region still face very high threats from the complex and difficult problems concerning hill tribes, lowland people, and government policy. No standard solution can ease the problems in this region. This should be a great concern for the government when creating any development policies, since many parts of the areas are watershed areas of the country.

Recreation activities and urbanization are significant threats in southern Thailand. These occur both on the mainland and on islands. Recreational activities, resource harvesting, and tourists create great impacts to marine ecology in many marine national parks. Urbanization through development projects destroys natural resources along the coast. Many sensitive areas in the national parks or national forests need to be protected strictly.

4.7.2 System and Management Effectiveness

The findings from the evaluation of effectiveness of protected areas provide an overall picture of the system and management. The results suggest that the system of protected areas is effective, management of protected areas is moderate and overall effectiveness of protected areas is moderate (Table 5). Interpretation of the findings should be tempered by the fact that theses results are based on the opinions of the heads of protected areas and do not include outside parties such as the public, international organizations, other governmental organizations, and experts in universities. It is noticeable that there is no low index for either system or management effectiveness, whereas the indexes of the system for protected area functions and its performance in protecting and recovering from disturbance are both high, and all indexes of protected area management are moderate.

This study did not use GIS or biophysical characteristics that could apply concepts in conservation biology such as representativeness, irreplaceability, complementarity (Pressey et al.1996, 2002; Powell et al. 2000) to test efficacy of protected area system. To analyze system effectiveness by applying conservation concepts, a good database is serious barrier in Thailand.

My findings cannot be compared to other studies such as in India (Sing 1999) or parks in the tropics (Bruner et al. 2001b) since I used the different framework of questions, different approaches, different protected area systems, and different scales of studies. However, one common theme found among these studies is protected areas are significant in protecting natural resources. Future evaluation in Thailand should include more criteria that cover many aspects of system and management evaluation, e.g., the frameworks suggested by Hockings et al. (2000) for terrestrial protected areas and Pomeroy et al. (2002) for marine protected areas.

In conclusion, evaluation of effectiveness of the system and management from this study indicate both success and barriers to be overcome in the future. More importantly, the approach used in evaluation should be from the people both outsiders and insiders (MacKinnon et al. 1986, Kleiman et al. 2000). This would help to reflect the same issues from different viewpoints.

4.8 Conclusions

Because of the apparent success, protected areas in Thailand have rarely taken a serious step to evaluate protected area systems and management. The findings from this research suggest that overall threats to protected areas throughout the country have similar patterns when reviewed by categories (national park and wildlife sanctuaries) or region, including illegal hunting, illegal logging, land conversion for agriculture, extractive of non timber forest products, and the pressure from population living around the protected units. The findings also suggest high overall impacts from the threats in all protected areas, whereas the spatial and temporal scales of impacts are low, resistance of protected areas to threats is high, and resilience of areas also low.

The findings indicate that overall effectiveness of protected areas is at a moderate level, effectiveness of the system is high, but effectiveness of management is moderate. The results from this study reveals gaps in systems and management that are related to reserve design, selection, evaluation, prioritization, monitoring, and management. that need to be improved. This study also suggests a research direction that should be focused on improvement of reserve system and management, long-term ecological impact, utilization, and restoration.

Finally, Thailand has been successful in establishing new protected areas and expanding existing protected units in the last four decades. This success indicates a positive conservation direction, but it could reflect the fact that threats from land use is such a serious problem. It could also indicate the failures of land management in this country since most lands are set up to protect natural resources from threats of land use conflicts, as few lands were set up as protected area while free of threats. Along with success, conflicts have also skyrocketed due to limited available lands. What roles the government and the public should play in the current complex world is still a legitimate question.

Chapter 5

Gaps and Proposed Solutions for Protected Areas Management in Thailand

5.1 Introduction

Many issues emerged from evaluation of the effectiveness of protected area management and system in Thailand. For the system, I identified gaps in protected areas are design, selection, and prioritization. Size and locations of protected areas are still questionable, and many areas are still isolated and face high threats (Figure 3, Chapter 3). Also, some areas need to be re-categorized. For management, many issues create difficult problems, including unclear definition of protected areas, weak and conflicting in legislation, lack of national policy and planning, and boundary conflicts. However, three key areas, besides lack of evaluation, that become significant gaps in management are the lack of monitoring projects, lack of public participation, and weak research support and education. Other obstacles such as undermanagement, understaffing, and underfunding are also significant to protected area management.

The gaps identified in this study can guide future research direction and have management implications to managers and planners. However, protected area management is not static, but dynamic. Since managers in Thailand (and other tropical countries) have to deal with uncertainty and complex issues, to conduct an evaluation is much more difficult and complicated, and reevaluations need to be done over time. The conditions around the protected areas, the number of stakeholders, and the degree of problems change through time. It is important to reevaluate gaps and solutions periodically. More importantly, the implications from this finding are still on a case-by-case basis, and even in the same areas, as time passes alternative solutions should be applied.

5.2 How Could Concepts in Conservation Biology Be Applied to Protected Area Management in Thailand?

Conservation biology concepts can play crucial roles in the process of establishing protected areas. Two major concerns often used as criteria to protect biodiversity are maintaining habitats or areas that are in good condition or areas that are threatened. Usually after determining what ecological attributes should be protected, managers and planners can identify areas for protection by looking at the distribution of habitats or targeted organisms. Hotspots or naturalness of areas are two major criteria often used. In the past, there were ample areas available for protection; sometimes this allowed for bias in choosing areas. Protected areas often were chosen that had low habitat quality, have few targeted species, or were at a high elevation (Pressey 1994). At present, managers and planners may not have many choices to choose for protection since most areas are occupied or impacted by humans.

After knowing the status of target areas for protection, managers can establish individual reserves or reserve networks, depending on the status of targeted species and their distribution. If targeted species are concentrated in one area, setting a single large reserve could provide adequate habitat for the species. If targeted species or habitats are fragmented, a good strategy is to set up a reserve network by including both disturbed and undisturbed areas. By setting up networks and building connectivity, as well as expanding areas to include outside reserves, protected areas could protect targeted species more efficiently and maintain metapopulations through time.

When designing new areas, whether single areas or networks, a simple question of how much land is enough remains a crucial question. It depends on what criteria are used, such as how much land is available, how large the conservation target is, or how many targeted species, communities, or ecosystems need to be protected. In the past, we could design reserves that were large enough to meet the area needs of targeted species. At present, few large areas are available. Most countries set up arbitrary goals for protection (e.g., 10% in IUCN) and then try to protect available lands to meet that goal. For this reason, lands under protection in many countries are not adequate to provide habitats for targeted species. Although concepts from conservation biology have potential to guide managers and planners in designing new reserves and expanding existing reserves, applications will remain limited if conversion of forestlands to other land uses continue and key areas remain occupied by people.

I suggest how to choose approaches, or techniques, and consider conservation concepts to help in the tasks mentioned above (Chapter 2; Tables 7, 8 and 9; Appendix 1). For example, when designing a reserve network, we may apply the concepts of source and sink populations by selecting areas in a variety of conditions: good, deforested, or remnants. Choosing good areas and ignoring poor areas is problematic for two reasons. First, from an ecological viewpoint, the remnant may play a significant ecological role as a sink habitat (e.g., support a small population, or be habitat for migratory species, be a stepping-stone). Another reason is from social and political standpoints. In Thailand, control of an area is the most important aspect of protection of species relying on that land. If forestlands are used or converted, it is difficult to later get the land back into the protection system.

In expanding existing reserves, many conservation concepts used in designing new reserves could play significant roles. However, the crucial question is how to expand the reserve system since existing protected areas typically are surrounded by hostile environment, especially in developing countries. Expansion could be possible in areas surrounded by unoccupied forestlands (e.g., national forests in Thailand). It is generally difficult in developing countries such as

Table 7. Applications of conservation biology concepts to reserve design.

Design	Criteria	Conservation Concept/ Goal/Approach
What to protect? (Species, habitats, ecosystem)	- Threat/vulnerability: IUCN red list, CITES, national lists, endemic species, endangered ecosystem, rarity. - Richness, naturalness	-Rarity, threatened species, vulnerability, endemic species. - Richness, naturalness, ecosystem integrity, ecosystem health, ecosystem services, focal species/units, surrogate species/units, range of variability.
Why protect? (Reason)	- Status (i.e., endangered, threatened), species & habitat destruction/loss, vulnerability, threat, fragmentation, endemism, rarity, endangered ecosystem. - Richness, naturalness.	- Endemic, rare, fragmentation, vulnerability. - Ecosystem health, ecosystem services, ecosystem integrity, range of variability.
Where to protect (Location)?	- Hotspots (richness, rarity, endemic), species & habitat destruction/loss, vulnerability, fragmented habitats. - Richness, naturalness	-Hotspots (richness, rarity, endemic, metapopulation), species and habitat islands, source-sink populations. -Richness, naturalness, focal species/units,

Table 7. (Continued).

		surrogate species/units.
What type of reserve? How to protect? (Scale)	-Individual reserves. - Reserve networks.	-Individual reserves: island biogeography. -Network: network/connectivity (corridors/ stepping stones), meta-population. - Concepts, goals, and approaches for both individual reserves & reserve networks: sources- sink population, representativeness, complementary, irreplaceability.
What approach can be used in design?	-Species approach. -Area approach.	-Species (fine filter): focal species (indicator, keystone, umbrella, flagship), hotspot groups (richness, rarity, endemism), species status (threatened, endangered, vulnerability, PVA), source - sink population, representativeness, complementary, Irreplaceability. -Area/geology (fine/coarse filters): surrogate type (areas, vegetation types, geological types, functional groups, environments), ecosystem health,

Table 7. (Continued).

		ecosystem services, representativeness, complementary, Irreplaceability.
	- Combination approach (Species, areas, ecosystem).	-An ecosystem approach, ecoregion, source-sink population, metapopulation, range of variability, connectivity/network, ecosystem health, ecosystem integrity, ecosystem functions & services, representativeness, complementary, Irreplaceability.
How much to protect?	- Depends on how much land available, approach used (species, areas, or combination), and scales of reserve design (individual/ network, local/regional/continental).	-Species approach: MVP. - Area/geology approach: minimum area requirement, species-area relationship, island biogeography, - Combination: coarse filter, landscape ecology, ecosystem health, integrity, ecosystem functions, ecological services, range of variability.
	- Criteria: adequacy, representativeness, comprehensiveness flexibility, replication.	-Concepts: representativeness, complementary, irreplaceability.

Thailand to acquire sizable pieces of adjacent lands to add to the protected areas system because of a lack of infrastructure, funding, and available land.

Reclassification from one category to another should be done to improve protection efficiency. For example, since the wildlife sanctuary is the most strictly protected area in the protected area system in Thailand, re-categorizing many areas from national park to wildlife sanctuary would have conservation benefits. However, this rarely happens in Thailand since most national parks are set up to serve recreational purposes. More importantly, recently the government established a policy to use national parks as a major source to produce benefits from eco-tourism (Sretarugsa 2000, Ampholchan personal communication). Not only are national parks less likely to be re-categorized to wildlife sanctuaries, but national parks now face pressures from politicians, economists, and the private sector to allow concessions to operate tourism inside protected portions. There are many concerns in giving concessions to private sectors conducting tourism in protected areas that the government should consider. If the government is considering giving a concession in any protected area, a pilot study and mitigation plan should be in place prior to implementation. Thailand usually categorizes areas to increase the efficiency of protection by changing the status of forest areas from non-hunting area or national forest to wildlife sanctuary or national parks. There have been some attempts in the RFD to re-categorize wildlife sanctuaries to national parks with recreational purposes. This is a crucial strategy for the country. As long as

Table 8. Applications of conservation biology concepts to reserve selection.

Selection	Criteria	Conservation Concept/goal	Approach/ Technique	Tool
How to select new reserves?	- What to protect (objectives)? Criteria: - Species status, hotspots, focal species, surrogate species & units, richness.	-Island biogeography, meta-population, source-sink population.	-Species approaches, area approach, or combinations. - Focal species, surrogate species and units.	- Existing records. - Survey and mapping.
	- Based on type of reserve (individual, network) and scale. Criteria: (1) Individual: species status, hotspots, focal species/units, surrogate species/units, areas (e.g., fragmentation).	-Island biogeography, metapopulation, source population, sink habitat.	- Focal species, surrogate species & units. - See below: (approaches for individual and network).	-PVA programs, mapping, programs (e.g., C-plan). - Algorithm.

Table 8. (Continued).

	(2) Network: species status, hotspots, focal species, areas, surrogate units, meta-population, source-sink population.	-Metapopulation, source population, sink habitat. - Concepts and goals for reserve individuals and networks: meta-population, source-sink population, naturalness, ecosystem health, ecosystem integrity, ecosystem functions & services, range of variability, representativeness, irreplaceability.	- Connectivity (corridor, stepping-stone). - Approaches for reserve individuals and networks: mathematical, algorithmic, ad hoc. - Complementarity.	-GIS, Gap analysis.
	- Based on which design approach (species, area, combinations).			
	Criteria: (1) Species: (national/local)	-Island biogeography.	- Fine filter, focal species, surrogate	- Mapping, PVA programs.

Table 8. (Continued).

	species list, IUCN read list, CITES.		species. - Approaches: mathematical, algorithmic, ad hoc.	
	(2) Areas: fragmentation, vulnerability	- Naturalness.	- Coarse filter, focal units, surrogate units, ecoregions. - Approaches: mathematical, algorithmic, ad hoc.	- GIS, Gap Analysis.
	(3) Combinations: focal species/units, surrogate species/units.	- Focal species, surrogate units, ecosystem. - Concepts and goals for three all criteria: meta-population, sources-sink population, representativeness, complementary, Irreplaceability, ecosystem health, ecosystem integrity, ecosystem functions	- Combination (coarse & fine filters). - Approaches: mathematical, algorithmic, ad hoc.	- Combination (Coarse & fine filters): GIS & Gap Analysis.

Table 8. (Continued).

		& services, range of variability. Scale: local, landscape, regional, continental.		
How to expand existing reserve?	- Based on what to protect (objective)? Criteria: - Richness, rarity, endemic. - Based on what types of (existing) reserves, (individual, network) and why. Criteria: (1) Individual: species, habitats, or ecosystem status (e.g., threats, vulnerability, fragmentation), species or area	- Concepts and goals for reserve individuals and networks: island biogeography, source-sink population, meta-	- Approaches for both: algorithm, ad hoc. - Hotspots (richness, rarity, endemics). - Focal species/units, surrogate species/	- See also: "What to protect" (Table 7); "How to select new reserve (above)." - See also how to re-categorize (below). -See also: "What type or reserve (Appendix 8)?" - See also how to re-categorize (below). - Threats and vulnerability: see IUCN red list, CITES, national lists. - Related to how much is enough, how much land is

Table 8. (Continued).

	adequacy. (2) Network: species, habitats, or ecosystem status, species or area adequacy, comprehensiveness, flexibility, replication. - Based on level of significance of the area. - Based on how much lands available, or how high the conservation target is (25%-75%.).	population, naturalness, ecosystem integrity, ecosystem health, ecosystem services, range of variability, representativeness, irreplaceability.	units. - Complementarity.	available, and what the objectives of management are. - Tools for both: species lists (records), GIS, PVA programs. - For adequacy, see how to re-categorize (below). - See how to re-categorize (below).
How to recategorize reserves?	Criteria: (1) Objective of management: assessing an existing category and	- Concepts and goals for all criteria: source-sink populations, meta-	- Approaches for all criteria: hotspots (richness, rarity, endemics), focal	-Tools for 3 criteria: (1) Laws, regulations. (2) GIS & Gap Analysis.

Table 8. (Continued).

	management objectives. (2) Status of target species (or areas): current status of target/groups of species, level of species, level of protection, level of impacts. (3) Adequacy of species (e.g., MVP) or areas (e.g., areas for focal species). (4) Level of significance of existing natural resources: richness, rarity, endemic, level of significant at national, or international (e.g., world heritage sites).	populations. naturalness, ecosystem integrity, ecosystem health, ecosystem services, range of variability, representativeness, Irreplaceability.	species, surrogate species & units, complementary.	-Strengthen by (1) change legal status, or management under objectives of reserve categories; or (2) expand reserves, or building connectivity. - For (1) see how to manage (based on what objective section). - For (3) and (4) see how to expand existing reserve (above).

economic and political motivations supersede ecological goals, Thailand will have a difficult time solving many problems in natural resource management.

This social, economic, and political context impacts application of any conservation strategy in protected area management. Therefore, it is important that managers or planners who want to implement conservation concepts understand the complexity and uncertainty of problems beyond the boundaries of protected areas.

5.3 Limitations and Constraints in Applying Concepts in Protected Area Management in Thailand

Protected area managers in Thailand face many limitations and constraints in implementing their work on the ground. A lack of resources is common. For example, the staff of the forestry department and the government sector have long been impacted by lack of an updated database. Lacking support from their own administrators causes inefficiency in solving problems on the ground. As is well documented in many publications (e.g., RFD 1993a, 1993b, 1993c, 1993d, 1994, 1996a, 2001b, 2002), lack of resources is a key factor causing inefficiencies in management. The question is how to solve the problems if the country ignores investing in natural resource protection.

Thailand faces constraints similar to those of other developing countries in research and natural resources management (Edge 1993, Prins and Wind 1993,

Table 9. Applications of conservation biology concepts to reserve management

Management	Criteria	Conservation Concept/Goal	Approach/ Technique	Tool/Remark
How to manage reserves?	-Depending on objectives. (1) Protect existing species or areas. Criteria: Richness (e.g., focal species). (2) Protect critical existing species or areas. Criteria: Threats/vulnerability: IUCN red list, CITES, national lists, fragmented habitats, endemic species, endangered ecosystem.		- Strict reserves, or compromise reserves under specific regulations (e.g., buffer zone management). - Strict reserves.	- Existing species or areas may not necessarily be in danger. - Valuable habitat: transmigration areas, breeding areas. - Existing species or areas are in danger.

Table 9. (Continued).

	(3) Protect process and function: range of variability, ecosystem integrity, ecosystem health, ecosystem services.		(1) Strict reserve (2) Compromise reserve under restricted regulations.	
	Overall criteria: status of target species, areas, or both.	- Concepts and goals for all criteria: naturalness, ecosystem integrity, ecosystem health, ecosystem services, range of variability.	- Approaches/ techniques for all criteria: fine and coarse filters: species and area/habitat protection include transboundary habitats for migratory species; techniques include reintroduction, translocation.	- For all criteria: see IUCN categories, international agreements (i.e., RAMSAR, ASEAN heritage, National Wildlife reserve). - GIS. - See techniques and tools in in situ/ ex situ. - Other techniques used in reserve types, e.g., buffer zone, ICDP, community forestry. -Recategorize to increase level of

Table 9. (Continued).

				protection (if necessary, Table 8).
	-Depending on type of reserve category. Examples of categories: -National park. -Wildlife refuge/sanctuary.	- Naturalness, ecosystem integrity, ecosystem health, ecosystem services, range of variability.	- Strict protection. - Compromise approach (ICDP, community forestry, sustainable forestry, agro-forestry, zoning techniques, buffer zone.	- Zoning (other concepts from park & recreation could be applied, i.e., LAC, ROS, carrying capacity). - Wilderness concept and management). - GIS, gap analysis.
	- Depending on type of reserve. (1) Individual.	- Island biogeography.		-Individual (PVA software). -Network (GIS, Gap Analysis). - Apply biosphere reserves.

Table 9. (Continued).

	(2) Network.	-Metapopulation, fragmentation.	- Network/ connectivity (corridors/ stepping stones).	-Gap Analysis Natural/man made connectivity (corridor/stepping stone).
		- Concepts and goals for both individual reserves & reserve networks: sources-sink population, representativeness, irreplaceability.	- Approaches for reintroduction, translocation, buffer zone, corridor/stepping stone.	
	-Depending on conditions of the reserve (individual or network).	- Concepts and goals for both individual and reserve networks: metapopulation, source-sink populations, representativeness, irreplaceability.	- Approaches for both individual and reserve networks: buffer zone corridor/stepping stone.	- Individual (PVA software). - Network (GIS, Gap Analysis). - Apply Biosphere reserve. -Gap Analysis - Natural/man-made connectivity (corridor/stepping stone).

Table 9. (Continued).

	-Depending on scale of management.	-Concepts and goals for all scale: sources-sink population, meta-population, representativeness, irreplaceability.		-Tools for all scales: Gap Analysis Natural/man made connectivity (corridor/Stepping stone).
	(1) Local.		- Building connectivity.	-Apply biosphere reserve (e.g., buffer zones).
	(2) Regional.		- Build network.	- Management approach at a landscape scale.
	(3) National.		- Build network or connectivity.	
	(4) Continental.		- Building connectivity and apply the transboundary approach.	
	-Depending on			

Table 9. (Continued).

	condition of management (matrix, inside & outside, mix category of lands).			
	Criteria: (1) Fragmented or isolated reserves.	-Metapopulation, source-sink.	-Building connectivity. -Buffer zones.	- Remote sensing, GIS, and Gap analysis.
	(2) Mosaic reserves and outside.	- Source-sink population, meta-population.	- Building large-scale connectivity (corridor/stepping stone). -Buffer zones.	- Apply compromise approaches (e.g., community forestry) to decrease the hostility of the environment.
	(3) Multiple ownerships.	-Source-sink populations, meta-population.		
		- Related concepts for all criteria: representativeness, irreplaceability.		Related approaches for all criteria: complementary.
	-How much land is			

Table 9. (Continued).

	available. Criteria: - Target of protection and land available.	- Concepts and goals for individual or reserve network (with/without buffer zone): meta-population, sources-sink, representativeness, irreplaceability.	- Private parks, - Agricultural parks. - Strict protected areas. -Expand individual reserve, or reserve network. - Approaches: complementary.	-Use incentives: ecological easement -Apply restoration ecology concept to rehabilitate lands. -Apply GIS and gap analysis. -Expand areas to meet objectives.

Nair et al. 1995, Pipithvanichtham 1997, Sodhi and Liow 1999). Unstable political systems, economic problems, social changes, and culture shock are well rooted in Thailand.

In short, these limitations and constraints, combined with management under complex and uncertain conditions in the country and threats from other countries (e.g., free market, import-export policies), play major roles in the ineffectiveness of protected area management. Though the majority of Thai people believe that the country has never been colonized by western countries, the reality is that Thailand has long been informally colonized through the education system, media, political system, economics, and social development. Although this informal colonization has had a positive impact on economic development, it also has had negative impacts leading to the destruction of natural resources. These result from application of concepts in economic development, technological development, and social changes imported by the students who graduated from other countries. Many mistakes in protected area management are mainly due to misunderstanding and ignorance, as well as the illusion of development, which prevents administrators, politicians, and the public from taking good care of the environment in this country.

5.4. Existing Issues Related to Effectiveness of Protected Area Management

(1) Government policy and mismanagement of natural resources in Thailand. As has been well documented, government policy is a major cause of deforestation in the tropics (Repetto 1988, 1990; Gillis and Repetto 1988, 1993; Poore 1993; Roper and Roberts 1999; Geist and Lambin 2002). The policy of the Thai government to encourage production of agricultural crops and goods for exportation has resulted in destruction of forests. This policy, in combination with the policy of providing loans to farmers and setting up production targets, encourages farmers to encroach forestlands in protected areas. Because of this increase in agricultural production through land expansion, forest areas have become easy targets for encroachment. The result of this government policy in the last four decades has been conversion of most of the forestlands through illegal encroachment to produce agricultural products to export to the international market. This exportation policy, in combination with the land reform project that transformed forestlands to the wealthy, as well as the conflicts in land use policies of many government agencies, has substantially increased the rate of natural resources depletion.

Tourism and mass consumption promoted by government policy also contributes to resource extraction and overexploitation. Though there is no research conducted in Thailand concerning how much forest destruction has resulted from tourism, negative environmental impacts have occurred in protected areas where mass tourism was allowed (e.g., Khao Yai National Park). Besides ecological impacts, other impacts such as over-consumption, collection of souvenirs, and sports are hidden contributors to the destruction of natural resources in this country. For example, many people in Asia believe that eating parts of wild species increases sexual potency. This leads to illegal exportation of animal parts from Thailand, Laos, Burma, and many other Asian countries to other countries in Asia. Another example is that collecting of orchids, wildlife, trophies, or other items may impact the genetic conservation in developing countries. In addition, the blossoming of hobby or professional sports of people in one country can lead to the destruction of natural resources in another country. Finally, golf courses, which have mushroomed in the last decade, have created multiple problems in Thailand because the country is faced with lack of habitat for wildlife and available lands for people and water crises in summer.

(2) Conflict resolution, public participation, and attitude of the public toward protected area management. Conflict resolution, public participation, and attitudes of the public to protected area management have become central to protected area management in Thailand in the last decade. Because many factors mentioned above increase resource consumption, conflicts often occur wherever protected areas are set up. Recently, resource use conflicts, along with a lack of evaluation of effectiveness, have received attention from interested groups, such as

environmentalists and the mass media. On one hand, some may argue that present processes used in design reserve of the system and its management have created problems concerning land ownerships and rights of resource access (Vandergeest 1996b, 1999). On the other hand, some argue that the problems were not caused by the system itself, but by various groups who want to take and control natural resources (Dearden et al. 1998). Though many approaches have been applied to solve problems, conflicts will continue to exist as long as the population keeps growing and impacts from globalization still invades forestlands.

Though we generally accept that managing natural resources without including local people is cause for failure, community forestry, sustainable forestry, or any kind of public participation are just some for the options of management. Success in one area does not guarantee that it will succeed in other areas (e.g., Adams and Hulme 2001).

5.5 Challenges of Protected Area Management in Thailand

Protected area management in Thailand now faces a crisis in protecting natural resources. As is the case in most countries, most problems in natural resources management are complex. One major challenge for Thailand is land use conflicts. This conflict cannot be solved by one organization (the RFD) since the problems are created by many groups of people in the society. The challenge here is how to bring those that created the problems together to solve their own problems.

Another challenge is that conservation alone cannot protect natural resources. Protecting biodiversity requires more than just protection of forest habitats. As long as people in the country rely mainly on natural resources, the government needs to finds way to strike a balance between protecting key areas and managing forest areas to meet the needs of the people. All previous policies related to land management need to be revisited. All import-export policies that have direct or indirect impacts to transfer, or destroy, natural resources need to be reviewed. More importantly, we should be cautious of creating an illusory and inconsistent conservation policies that do not take regional or global implications into account.

It is well understood that protected areas alone are inefficient to protect biodiversity (Allison et al. 1998, Mascia 2001). Though protected areas are essential for conservation (Sobel 1996), they need support from the public and political will to accomplish conservation goals (Bradshaw and Borchers 2000, Bradshaw and Bekoff 2000). Since protected areas are considered to be one management tool to slow down the destruction of biodiversity, they could be the most effective means in a hostile environment with high threats and pressures (Kramer et al. 1997, Lubchenco et al. 2003). Since no other current approach better protects biodiversity, many countries still use this approach. Some might suggest that the success in establishing protected areas indicates the failure of conservation in the country. However, conflicts related to setting up new protected areas, or expanding existing areas, often do not imply that protected areas are ineffective. Rather, protected areas provide a protection strategy to protect biodiversity inside the protected area (Worboys et al. 2001). In many cases, though areas may not be declared as protected areas, land use conflicts still occur as long as populations keep growing and the available land is limited.

Protected area management in Thailand is now at a crossroads. To survive under pressure from international threats, the country needs clear direction, such as a protected area policy. The old national forest policy and recent natural resources policies (OEPP 2003) do not provide adequate direction. However, the most important thing is policy implementation on the ground. Because Thailand is situated as a land bridge in Southeast Asia, the country plays a critical role as a corridor and a buffer area for wildlife movement between Asian countries. With this important role, protected area management in this country could provide significant habitats for species throughout the region. Besides managing protected areas inside the country, other options such as transboundary-protected areas should gain more attention. Because of its significant role, Thailand has participated in a number of international agreements such as RAMSAR, CITES, World Heritage Convention , Asian Declaration on Heritage Parks and Reserves, and Asian Agreement on the Conservation of Nature and Natural Resources (Galt et al. 2000a, Wiryanti 2000). Protected area management in Thailand does and will continue to face pressure both from inside and outside the country. Therefore, as long as Thailand struggles with the key issues mentioned in sections 5.1, 5.3, and 5.4, the country will have difficulty effectively implementing international agreements.

5.6 Future Research

Determining approaches to solve conflicts in natural resources and build capacity are two key areas in need of future research in protected area management in Thailand. Methods of solving conflicts is the most important issue for government staff who are working in protected area management, as they need to learn appropriate approach and apply them to conflict resolution along with their work on protection. Because conflicts often differ by region, success in solving problems in one area does not guarantee success in another. More importantly, opportunities for scientific research will not last long if we cannot slow down or stop threats occurring around protected areas. Since the government has limited resources, cooperation with outside researchers and organizations could expand research efforts. Also, a prioritization research topics and areas is necessary.

Another key research area is the building capacity for protected area management. Issues and gaps found in Chapters 3 and 4, and Table 6 provide the basis for guidelines concerning research dimensions (Table 10). In brief, to support

Table 10. Research direction of protected area management.

Topics/Research Issues	Rationale/Benefits	Research Direction	Comment/Reference
I. Protected Areas (1). Protected Area System. - Lack of (updated) database for protected area management. - Lack of database to evaluate effectiveness of protected area system.	- Existing data are out of date and distribute in different offices and forms. - Updated and new data can be used in protected area management, evaluation, effectiveness, planning, monitoring. - Build up GIS for the protected area system (both for individuals and networks) that can be applied with gap analysis to design new reserves, expanding existing protected areas, building connectivity, and evaluate effectiveness. - Provide update information for policy makers (e.g., ministerial meeting, cabinet meeting), or conflict resolutions.	- Collect new data in protected areas to build up the database for protected area system and management.	- Need to conduct immediately. - Build up database 5-10 kilometers outside protected areas. Examples of questions: Does species on the record still exist? What are species (never survey)? - Expand works by Kanjana (2000), Prayurasiddhi et al. (1999), Jintanugool et al. (1982), Santisuk et al. (1991), and Brockelman and Baimai (1993). - See gap of work on Table 6. - Obstacles: high cost and long term project to build up database.

Table 10. (Continued).

(2). Protected area management. - Lack of evaluation effectiveness of protected area management.	- Benefit to the department and the public to evaluate efficiency of work.	- Research to set up a protocol to evaluate effectiveness of protected area management by using both internal and external team.	- The protocol should be improved by the Park, Wildlife, and Plant Conservation following the situation and adaptive management. - Obstacles: Evaluation is the difficult work in developing country (e.g., complex problem and high uncertainty).
- Lack monitoring projects.	- Use results from monitoring projects in evaluating protected area system and management. - Use updated information in threat analysis. - Apply findings to adaptive management. - Information can be used in planning and set up policy.	-Set up long term monitoring research projects to monitor changes in potential threats (e.g., population growth, land use expansions) both inside and outside protected areas. - Set up projects to monitor changing of target species or community inside protected areas.	- Obstacles: need to invest more resources (e.g., manpower, budget), difficult work, little incentive, and long term. - Noss (1990, 1999); Goldsmith (1991); Kremen et al. (1994,1998); Noon (2003), Noon et al. (1999); Busch and Trexler (2003).

Table 10. (Continued).

- Lack of national policy for protected Area.	- The policy will be the guideline for long term protected area management.	-Research to set up the policy at national level for protected areas.	- Policy should be compatible with protected area national system plan. - Obstacles: Society and political needs sometimes overwrite policies.
II. Ecological Research (1). Long-term ecological impact projects. - Lack of a study on the impacts from human activities (e.g., hunting, logging) on plants and wildlife species.	- The findings will benefits in threat analysis in short and long terms. - Information and findings can be used in reserve design, selection, expansion, re-categorization, evaluation, prioritization (both to prioritize areas for protection and invest resources and budget). - Information can be used by policy makers to make decisions related to protected areas. - Findings can be applied	- Research on long-term ecological impacts of land uses or threats to species, community, and ecosystem at different scales. - Research on long-term ecological impact of fragmentation to species, community, and ecosystem at different scales (e.g., expand worked by Pattanaviboon 1999, Pattanavibool and Deardren 2002.), including impacts from silvicultural practices (Pattanavibool	- Impact from recreation should focus on both the short and long term since in some areas short impacts from tourist need to be solved quickly. - Obstacles: Lack of resource support. Many problems in some areas are complex and change landscape rapidly; therefore it is difficulty to evaluate long term impacts outside protected areas. It may work inside protected area, and research projects that use remote sensing

Table 10. (Continued).

	in adaptive management and management approach around protected areas. - Findings could be applied to formulate planning and policy.	1993, Pattanavibool and Edge 1996).	data.
(2). Long term ecological studies on tropical rainforest, wetland, and mangrove forests. - Influences of disturbance at different scales in determining structure and composition of different forest types are poorly known. - Effects of historical context of landscapes on ecosystem patterns and processes on different temporal and spatial scales are poorly known. - The effects of different types of disturbances on different forest types and	-Increase knowledge and understanding on influences of different types of disturbance and historical context of landscapes on different forest types, ecosystem patterns and processes on different temporal and spatial scales, and landscape mosaic in tropical forests. - Increase knowledge and understanding in tropical ecology, as well as ecological services and protected area management. - Apply findings to	- Research on long-term ecological impact of invasive species and global warming to species, community, and ecosystem at different scales. - Various topics in tropical ecology should be researched, e.g., forest fires, carbon studies, below ground studies (fungi & mycorrhiza) in various forest types (both disturbed and undisturbed).	- Conduct exploratory research to identify significant topics and priority. - Expand work by Bunyavejchewin et al. (1998) and works conducted by researcher from Forest Research Office (e.g., mangrove forest, silvicultural practices) and the faculty members from the Faculty of Forestry, Kasetsart University. - Obstacle: Lack of resource support. Many problems (e.g., illegal activities) still are hurdles

Table 10. (Continued).

landscape mosaic are poorly known.	protected area management. - Apply results to reforestation and rehabilitation projects.		if conducting in areas that are not well- protected. - Swanson et al. (1988), (1997); Franklin (1989); Franklin, et al. (1990); Swanson and Sparks (1990); Hansen et al. (1991); Perry (1994); Spies (1997), (1998); Spies and Turner (1999); Swanson and Molina (2000); Bradshaw and Marquet (2003), Turner et al. (2003).
- Karsts, cave, and key landscapes still lack research.	- Increase understanding and apply finding to protection strategies or tourism in some protected areas.	-Focus on karsts, cave, and key landscapes that still exist both inside and outside (if feasible) protected areas.	- Besides conducting research in a small unit, the project should expand (if possible) to the landscape scale. - Some areas of caves contain cultural values and geological features. Now these areas are impacted from local people and tourists with less attention

Table 10. (Continued).

			to management based on ecological basis. Obstacle: lack of staff and expertise. Conducting research entire landscape need more support from the department.
III. Restoration - Disturbed areas and need to be restored.	- Results from the research could be used in restoration projects both inside and outside protected areas. - Apply results to monitoring projects.	- First priority of restoration research project should focus on deforestation in key and sensitive areas and significant wildlife habitats. - Second priority should focus on rehabilitation along boundary of protected area.	- Reforestation projects done in Thailand are still a few percentage compare to areas lost (Werner and Santisuk 1993). - Rehabilitation project along the boundary help to build up buffer, increase cooperation between government staff and local people, and incorporate project to other projects (e.g., ICDP, community forestry). - Obstacle: Limited areas along the boundary of protected areas since most

Table 10. (Continued).

			areas are encroaches, or occupied by people. A pilot study on the feasibility of restoring wildlife species should be conducted throughout the protected areas. - Saunder et al. (1993a), (1993b); Brown and Lugo. (1994); Cairns (1995); Falk et al. (1996); Urbanska et al. (1997); Covington et al. 1999; Maehr et al. (2001); Morrison (2002); Perrow et al. (2002a), (2002b).
IV. Social science (1) Long term sociological project:	- Government could apply results in considering development projects. - Apply findings to the national social and economics development plan.	- Research should focus on the study of impacts from social, economic, and development projects to protected areas.	- Though there are EIA in the developed areas, EIA is not enough tool to indicate long term impacts from development to forest areas and most of development projects impact to protected areas still lack of long term study. Though there might be projects done in

Table 10. (Continued).

			some areas, those project look at small scales. -Obstacle: Social and political needs often ignore ecological impacts to protected areas.
(2). Conflict resolutions in protected area management. - Many protected areas still face with conflicts such as land uses, resource extraction, and recreation in sensitive areas.	- Findings from research in each case could be improved protected area efficiency. - To apply conflict resolution to adjacent areas, or adaptive management. - Findings could be used to inform public in public relation projects.	- Focus on pattern, process, mechanisms, solution, and alternatives of conflicts. - Focus on conflicts resolutions in different groups involved in different spatial and temporal scales.	- Though RECOFT are working on this issues, the idea that humans can live with nature still opposite to the principles of protected areas managed by the government. Therefore, few findings are applied to protected area management. Also, there are many cases of conflicts that have never been studied or recorded. - Examples of conflict resolution projects are both successes and failures, especially from flagship projects (e.g., ICDP, ICM,). The study should

Table 10. (Continued).

			learn from both sides and application should be based on a by case basis. - Wondolleck (1988), Wondolleck and Yaffee (2000); Emphandhu (1992); Tanakanjana (1996), Tanakanjana and Haas (1997); Yaffee and Wondolleck (1997); Newmark and Hough (2000); Adams and Hulme (2001); MacKinnon (2001), MacKinnon and Wardojo (2001); Lewicki et al. (2003).
(3). Traditional and indigenous knowledge. - Knowledge from local people gains less attention from research projects. This knowledge would be gone if the government does not support this kind of project.	- The findings could be applied with flagship projects (e.g., ICDP, ICM, sustainable forestry, community forestry).	- Should conduct exploratory research to find out target groups of indigenous people. - Focus research on traditional knowledge both inside and outside protected area.	- Though there are some research projects that try to gather the knowledge in pharmacy, the percentage is still small. There are many groups of local people around the country that have much more knowledge.

Table 10. (Continued).

			- Obstacle: Research in this area still need a lot of effort from researchers and support from the government. - Laird (2002).
V. Economics and Utilization. - Lack of research finding to inform public about benefits form protected area to society.	- Findings could be used in education and public relation indicating how important of protected area to society not only on economics but ecological services as well. - If careful studies, findings from this type of research and ecological impacts could be applied to set up policy and planning for tourism in and around protected areas.	- Focus not only on ecological benefits but on economic and social benefits as well. - Research should be conducted in different spatial and temporal scales.	- Often times, short term benefits from recreations are over estimated to long term benefits from ecological services that lead to allow activities in (eco) tourism occur in the sensitive areas. - Obstacle: integrated projects are difficult to conduct and implement. Many factors could have negative impacts on the outcome of projects.
- Forest products and non-timber forest products	- Results could be applied in using forest product	- Conduct a problem analysis to find key topics	- Many timber and non-timber forest products (are

Table 10. (Continued).

should gain more attention and support.	more efficiently. - Results from non-timber forest products could be applied in long term using manners, which will help preserve genetic diversity in protected areas.	related to forest products and non-timber forest products. - Research in forest products should focus on small scale and larger scale use.	in crisis in some protect areas resulting from mass harvesting to export at international market. - Obstacles: Difficult to conduct in some areas since most existing timber species and non-timber forest products are in the wild.

capacity building in protected area management, resource protection, utilization, and restoration should gain more attention and receive more support (Mackinnon 1997, Frumhoff and Losos 1998, Gullison et al. 2001). Protected area management techniques, such as conservation approaches and reserve management, could help increase the capacity of the reserve system (MacKinnon et al. 1986, McNeely 1995, Stolton and Dudley 1999). Though research in this field has been taken further in other parts of the world (e.g., Pressey et al. 1996, 2002; Pressey and Taffs 2001; Scott et al. 2001a, 2001b), research in Thailand is still in its infancy. Optimizing resource utilization, including non-timber forest products, efficiency of wood utilization, and resource harvesting, need to be studied since people in rural areas still rely on forests. More efficient use of forest products would help relieve pressure from illegal exploitation of protected areas. In the future, the country will face a shortage of woods and wood products. It is the responsibility of everyone to make sure that if we have to use forests as major sources to survive, we use them efficiently. More importantly, the Thai people need to restore disturbed ecosystems not only inside protected areas but outside as well. Though considerable research on silvicultural practices has been conducted in Thailand, the rate of restoring ecosystems continues to lag behind the rate of utilization or destruction. In many parts of the country, watersheds need to be rehabilitated and freshwater ecology need to be restored. Also, coastal ecosystems (e.g., mangrove forests), many of which were destroyed in the last 30 years (Charuppat 1992, 1994, 1997), need to gain more attention to be restored.

Finally, are protected area systems and management effective? Yes, it is based on my findings, but this question is still difficult to answer if the definition of effectiveness and the scope of the evaluation are different. Do protected areas include only national parks and wildlife sanctuaries, or do they include other types of forest areas (national forest category C, watershed areas)? One's definition of "effective" also depends on what we mean by system, management, or an area itself. What should be evaluated to measure effectiveness is still an open question. Evaluation of effectiveness is and will be the hot topic in protected area management in Thailand. Since populations are still growing, and fewer forestlands and natural resources are available, the country will face more serious questions in the future.

Chapter 6

Conclusions

The main objective of this study was to evaluate the effectiveness of the present protected area system in protecting natural resources in Thailand and evaluate use of conservation biology concepts in reserve area management. I conducted this evaluation by reviewing literature and the documents of the Thai Royal Forest Department, analyzing questionnaires sent to the heads of protected areas (wildlife sanctuaries and national parks), interviewing the staff of the RFD who have worked in protected area management in the last three decades, visiting sites, and discussing with experts in the university and are working on the ground.

From this research I found that protected areas in Thailand are relatively effective and play a significant role in protecting biodiversity. In addition, this study also suggested that overall threats to protected areas throughout the country are illegal hunting, illegal logging, land encroachment, extraction of non-timber forest products, and pressures from populations living around the protected units. These patterns of threats are also found when reviewed by regions and protected categories. Impacts from the threats are high in all protected areas, whereas scales of impacts are low, resistance of protected areas to threats is high, and resilience of areas also low. Overall effectiveness of protected areas is at the moderate level, effectiveness of the system is high but effectiveness of management is moderate.

This study also reveals gaps occurring in the protected areas system and management which need to be improved: (1) the size of protected areas is small; (2) protected areas are isolated, and conflicts in resource uses and boundaries still exist in many areas; (3) criteria for prioritizing areas for protection based on ecological, socioeconomic, and political factors, or resources for management are lacking; and (4) some protected areas need to be reclassified to more appropriate categories. Also, gaps found in protected management which need to be improved are: (1) misunderstanding in definition of protected areas; (2) conflicting legislation; (3) lack of a specific policy for protected area management; (4) ineffective organization of groups that oversee protected areas; (5) weak management and protection; (6) lack of tools used in management; (7) lack of national planning and management plan; (8) lack of protected valuation; (9) lack of monitoring projects in protected areas; (10) inadequate research and education related to protected areas; (11) weak public relations and involvement; and (12) a lack of understanding of international agreement by the staff of the government and the public.

To close these gaps, various recommendations have been provided, including expanding and re-categorizing existing areas, setting up criteria for prioritization, building connectivity, formulating policy and planning at national level, reorganizing institution, setting up monitoring and evaluation projects, and increasing public participation, research projects and education to the public.

My findings also suggest an overall guideline for how conservation biology concepts can be applied to protected area system and management (Tables 7, 8 and 9) under the limitations of resources and constraints of unstable politics, economic problems, and social and cultural changes in Thailand. I also suggest models, techniques, indicators, and rapid assessment framework that could be applied in protected area management (Appendices 5-14).

Significant aspects from the evaluation effectiveness of protected area management suggest challenges for future work, including: building databases that can be used in reserve design, selection, prioritization, expansion, re-categorization, and evaluation of system and management effectiveness; setting up reserve networks; and setting up frameworks and projects on monitoring, conservation planning, evaluation effectiveness, and rapid assessment of terrestrial and marine protected areas. These findings define the future research direction that should focus on conflict resolution, building up capacity of protected area system and management, restoration in deforested ecosystem, and utilization of timber and non-timber forest products (Table 10).

My study also suggested that three major problems in natural resource management in protected area management in Thailand are habitat destruction, resource extraction, and over-exploitation. These three problems are caused by governmental policy and mismanagement of natural resources, misunderstanding in natural resources management, and conflicts among groups of people in the society. To help protected area management face fewer pressures, the Thai government needs to solve these problems, along with evaluating the effectiveness of protected area management. More importantly, protected area management is an art and science. Managing protected areas in a changing world needs to consider impacts from global changes, invasions from species and globalization, threats from import-export policies, and unconventional impacts from international agreements.

Bibliography

Abbitt, R.J.F., J.M. Scott, and D.S. Wilcove. 2000. The geography of vulnerability: incorporating species geography and human development patterns into conservation planning. Biological Conservation 96: 169-175.

Adams, W.M., and D. Hulme. 2001. If community conservation is the answer in Africa, what is the question? Oryx 35: 193-200.

Agardy, T. 1994. Advances in marine conservation: the role of marine protected areas. Trends in Ecology and Evolution 9: 267-270.

Agardy, T. 1997. Marine protected areas and ocean conservation. Academic Press, London, United Kingdom.

Agardy, T. 1999. Creating heaven for marine life. Issues in Science and Technology 16: 37-44.

Albers, H.J., and E. Grinspoon. 1997. A comparison of the enforcement of access restrictions between Xishuangbanna Nature Reserve (China) and Khao Yai National Park (Thailand). Environmental Conservation 24: 351-362.

Alder, J., D. Zeller, T. Pitcher, and R. Sumaila. 2002. A method for evaluating marine protected area management. Coastal Management 30: 121-131.

Allison, G.W., J. Lubchenco, and M.H. Carr. 1998. Marine reserves are necessary but not sufficient for marine conservation. Ecological Applications 8: S79-S92.

Ampholchan, C. 2000 a. Recreation Opportunity Spectrum for recreation management in national parks in Thailand. A seminar paper, Department of Conservation, Faculty of Forestry, Kasetsart University, Bangkok, Thailand. Unpublished document (in Thai).

Ampholchan, C. 2000b. Development tools using Recreation Opportunity Spectrum for classification of recreation locations in national parks in Thailand. Department of Conservation, Faculty of Forestry, Kasetsart University, Bangkok, Thailand. Unpublished document (in Thai).

Ampholchan, C. 2001. Protected area prioritization. National Park Division, Royal Forest Department, Bangkok, Thailand. (Personal communication).

Andelmen, S.J., and W.F. Fagan. 2000. Umbrella and flagships: efficient conservation surrogates or expensive mistake. Proceedings of the National Academy of Sciences of the United States of America 97: 5954-5959.

Anderson, T.L., and A. James, editors. 2001. The politics and economics of park management. Rowman and Littlefield Publishers, Inc., Maryland, U.S.A.

Andreasen, J.K., R.V.O'Neill, R.F. Noss, and N.C. Slosser. 2001. Considerations for the development of terrestrial index of ecological integrity. Ecological Indicators 1: 21-35.

ANZECC. 1998. Guideline for establishing the national representative system of marine protected areas. Australian and New Zealand Environmental and Conservation Council (ANZECC), Task Force on Marine Protected Areas, Environment Australia, Canberra, Australia.

Batisse, M. 1982. The biosphere reserve: a tool for environmental conservation and management. Environmental Conservation 9: 101-111.

Batisse, M. 1997. Biosphere reserves: a challenge for biodiversity conservation and regional development. Environment 39: 7-33.

Bean, M.J. 2000. Strategies for biodiversity protection. Pages 255-273 in B.A. Stein, L.S. Kutner, and J.S. Adams, editors. Precious heritage: the status of biodiversity in the United States. The Nature Conservancy and Association for Biodiversity Information. Oxford University Press, New York, U.S.A.

Beissinger, S.R., and D.R. McCullough, editors. 2002. Population viability analysis. University of Chicago Press, Chicago, U.S.A.

Belbin, L. 1993. Environmental representativeness: regional partitioning and reserve selection. Biological Conservation 66: 223-230.

Beltran, J. 2000. Indigenous and traditional peoples and protected areas - principles, guidelines and case studies. IUCN, Gland, Switzerland and Cambridge, United Kingdom and WWF international, Gland, Switzerland.

Bhumpakphan, N., and U. Kutintara. 1993. Problems upon the survival of wildlife resource in protected areas under the management plan projects. Journal of Wildlife in Thailand 3: 27-42. (in Thai with English abstract).

Bolton, M.P., and R.L. Specht. 1983. A method for selecting nature conservation reserve. Occasional paper number 8, Australian National Parks and Wildlife Service, Canberra, Australia.

Bondrup-Nielsen, S., N. Munro, G. Nelson, J.H. Willison, T.B. Herman, and P. Eagles, editors. 2002. Managing protected areas in a changing world. Proceedings of the Fourth International Conference on Science and Management of Protected Areas, 14-19 May 2000, Wolfville, Nova Scotia, Canada. Science and Management of Protected Areas Association, Nova Scotia, Canada.

Boontawee, B., C. Plengklai, and A. Kao-sa-ard. 1995. Monitoring and measuring forest biodiversity in Thailand. Pages 113-126 in J.B. Boyle, and B. Boontawee, editors. Measuring and monitoring biodiversity in tropical and temperate forests. Proceedings of a IUFRO symposium, August 27-September 2, 1994, Chiang Mai, Thailand. Center for International Forestry Research (CIFOR), Bogor, Indonesia.

Borrini-Feyerbend, G. 1996. Collaborative management of protected areas: tailoring the approach to the context. IUCN, Gland, Switzerland.

Boyce, M.S. 1992. Population viability analysis. Annual Review of Ecology and Systematics 23: 481-506.

Boyle, J.B., and B. Boontawee, editors. 1995. Measuring and monitoring biodiversity in tropical and temperate forests. Proceedings of a IUFRO symposium, August 27- September 2, 1994, Chiang Mai, Thailand. Center for International Forestry Research (CIFOR), Bogor, Indonesia.

Bradshaw, G. A., and J. G. Borchers. 2000. Uncertainty as information: narrowing the science-policy gap. Conservation Ecology 4(1): 7. Also available from http://www.consecol.org/vol4/iss1/art7 (assessed 31 March 2002).

Bradshaw, G. A., and M. Bekoff. 2000. Integrating humans and nature: reconciling the boundaries of science and society. Trends in Ecology and Evolution 15: 309-310.

Bradshaw, G.A., and P.A. Marquet, editors. 2003. How landscape change: human disturbance and ecosystem fragmentation in the Americas. Springer-Verlag, Berlin Heidelberg, Germany.

Brandon, K., K.H. Redford, and S.E. Sanderson, editors. 1998. Parks in peril: people, politics, and protected areas. Island Press, Washington, D.C., U.S.A.

Brennan, S., and J.C. Miles. 2003. National parks, wilderness, and protected areas in the United State. Pages 45-60 in J.G. Nelson, J.C. Day, and L.M. Sportza, editors. 2003. Protected areas and the regional planning imperative in North America: integrating nature conservation and sustainable development. University of Calgary, Canada and Michigan State University Press, U.S.A.

Brigham, C.A., and M.W. Schwartz, editors. 2003. Population viability in plants: conservation, management, and modeling of rare plants. Springer-Verlag, Berlin Heidelberg, Germany.

Brockelman, W.Y. 1990. Wildlife conservation in Thailand: a strategic assessment. Pages 300-305 in J.C. Daniel, and J.S. Serrao, editors. Conservation in developing countries: problems and prospects. Proceedings of the Centenary Seminar of the Bombay Natural History Society. Oxford University Press, Oxford, United Kingdom.

Brockelman, W.Y., and V. Baimai. 1993. Conservation of biodiversity and protected area management in Thailand. Center for Conservation Biology and Department of Biology, Faculty of Science, Mahidol University, Bangkok, Thailand.

Brooks, T., A. Balmford, N. Burgess, J. Fjeldsa, L.A. Hansen, J. Moore, C. Rahbek, and P. Williams. 2001. Toward a blueprint for conservation in Africa. BioScience 51: 613-624.

Brown, K., and D.W. Pearce, editors. 1994. The causes of tropical deforestation: the economic and statistical analysis of factors giving rise to the loss of the tropical forests. University of British Columbia Press, Vancouver, Canada.

Brown, S, and A.E. Lugo. 1994. Rehabilitation of tropical lands: a key to sustaining development. Restoration Ecology 2: 97-111.

Bruner, A.G., R.E. Gullison, and R.E. Rice. 2001a. The effectiveness of parks. Science 293: 1007.

Bruner, A.G., R.E. Gullison, R.E. Rice, and G.A.B Fonseca. 2001b. Effectiveness of parks in protecting tropical biodiversity. Science 291: 125-128.

Bruner, A.G., R.E. Gullison, R.E. Rice, and G.A.B Fonseca. 2001c. Park and factors in their success: response. Science 293: 1045-1047.

Bryant, D., D. Nielsen, and L. Tangley. 1997. Last frontiers: ecosystems and economies on the edge. World Resources Institute, Washington, D.C., U.S.A.

Bugna, S.C. 2001. An overview of ASEAN protected area system. Asean Biodiversity 1: 27.

Bugna, S.C., and G. Rambaldi. 2001. A review of the protected area system of Thailand. Asean Biodiversity 1: 36-41.

Bunyavejchewin, S., J.V. LaFrankie, P. Pattapong, M. Kanzaki, A. Itoh, T. Yamakura, and P.S. Ashton. 1998. Topographic analysis of a large-scale research plot in seasonal dry evergreen forest at Huai Kha Khaeng Wildlife Sanctuary, Thailand. Tropics 8: 45-60.

Burkman, W.G., and G.D. Hertel.1992. Forest health monitoring. Journal of Forestry 90: 26-27.

Busch, D.E., and J.C. Trexler, editors. 2003. Monitoring ecosystems: interdisplinary approaches for evaluating ecoregional initiatives. Island Press, Washington, D.C., U.S.A.

Cairns, J. 1995. Rahabilitating damaged ecosystems. Lewis Publishers. Ann Arbor, Michigan, U.S.A.

Cairns, J., P.V. McCormick, and B.R. Niederlehner. 1993. A proposed framework for developing indicators of ecosystem health. Hydrobiologia 263: 1-14.

Caldecott, J.O., M.D. Jenkins, T. Johnson, B. Gloombridge. 1994. Priorities for conserving global species richness and endemism. World Conservation Monitoring Center (WCMC), WCMC Biodiversity Series Number 3. World Conservation Press, Cambridge, United Kingdom.

Carey, C., N. Dudley, and S. Stolton. 2000. Squandering paradise? The importance and vulnerability of the world's protected areas. WWF-World Wildlife Fund for Nature International, Gland, Switzerland.

Caro, T.M, and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. Conservation Biology 13: 805-814.

Carroll, C.C., R.F. Noss, and P.C. Paquet. 2001. Carnivores as focal species for conservation planning in the rocky mountain region. Ecological Applications 11: 961-980.

Chape, S. 2001. An overview of integrated approaches to conservation and community development in the Lao People's Democratic Republic. Park 11: 24-32.

Charoenpanij, S. 1993. Forestry legislation. Thai Forestry Sector Master Plan, Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

Charuppat, T. 1992. Analysis of forest situation in Thailand from Landsat Imagery. Office of the Remote Sensing Survey and Mapping, Royal Forest Department, Bangkok, Thailand. (in Thai with English abstract).

Charuppat, T. 1994. Using Landsat-5 (TM) Imagery for monitoring the changes of forest area in Thailand. Forest Resources Assessment Division, Forest Research Office, Royal Forest Department, Bangkok. (in Thai with English abstract).

Charuppat, T. 1997. Application of remote sensing in monitoring of tropical forest. Pages. 10-18 in Tropical forestry in the 21st century. Proceedings of FORTROP'96 International Conference, 25-28 November 1996, Kasetsart University, Bangkok, Thailand.

Chatty, D., and M. Colchester, editors. 2002. Conservation and mobile indigenous people: displacement, forced settlement, and sustainable development. Berghahn Books, United Kingdom.

Chettamart, S. 2001a. Experience with coastal and marine protected area planning in Thailand. Department of Conservation, Faculty of Forestry, Kasetsart University, Bangkok, Thailand.

Chettamart, S. 2001b. Protected area management: policy, planning, and management. Department of Conservation, Kasetsart University, Bangkok, Thailand. (Personnel Communication).

Chettamart, S. Undated. Protected areas: who should manage? Department of Conservation, Faculty of Forestry, Kasetsart University, Bangkok, Thailand. (in Thai).

Chettamart, S., U. Kutintara, S. Isavilanon, R. Sriwatana, P. Makarapirom, and N. Tanakarnjana. 1991. Protected area in Thailand: system expansion, size, and management consideration. Kasetsart University, Bangkok, Thailand.

Chettamart, S., and D. Emphandhu. 1994. The tourism industry and sustainable development in Thailand. TEI Quarterly Environment Journal 2: 39-46.

Chompoochan, M., J. Ragrat, G. Sakorwong, P. Ekachan, P. Ekachan, and C. Chreesaen. 1995. The inventory of settler in wildlife sanctuary. Journal of Wildlife in Thailand 4: 91-108. (in Thai with English abstract).

Clark, R.N., and G.H. Stankey. 1979. The recreation opportunity spectrum: a framework for planning, management and research. USDA Forest Service, Pacific Northwest Research Station, GTR-PNW-98, Portland, Oregon, U.S.A.

Cole, D.N., and S.F. McCool. 1997. Limits of acceptable change and natural resources planning: when is LAC useful, when is it not? Pages 69-71 in S.F. McCool, and D.N. Cole, compilers. Proceedings- Limits of acceptable change and related planning processes: progress and future directions. A workshop held at the University of Montana's Lubrecht Experimental Forest, May 20-22, 1997, Missoula, Montana. USDA Forest Service, Rocky Mountain Research Station, General Technical Report: INT-GTR- 371, Ogden, Utah, U.S.A.

Covington, W., W.A. Niering, E. Starkey, and J. Walker. 1999. Ecosystem restoration and management: scientific principles and concepts. Pages 599-617 in R. Szaro, N.C. Johnson, W.T. Sexton, and A.J. Malk, editors. Ecological stewardship: a common reference for ecosystem management. Volume II. Elsevier Science Limited, Netherlands.

Csuti, B., L.A. Graham, and J.M. Scott. 1995. Gap analysis: a spatial approach to identifying representative areas for maintaining biodiversity. Pages 537-541 in J.A. Bissonette, and P.R. Krausman, editors. Integrating people and wildlife for a sustainable future. The Wildlife Society, Bethesda, Maryland, U.S.A.

Daily, G.C., editor. 1997a. Nature's service: societal dependence on natural ecosystems. Island Press. Washington, D.C., U.S.A.

Daily, G.C. 1997b. Introduction: what are ecosystem services? Pages 1-10 in G.C. Daily, editor. Nature's service: societal dependence on natural ecosystems. Island Press, Washington, D.C., U.S.A.

Daily, G.C. 1997c. Valuing and safeguarding earth's life –support systems. Pages 365-374 in G.C. Daily, editor. Nature's service: societal dependence on natural ecosystems. Island Press. Washington, D.C., U.S.A.

Davey, A.G. 1998. National system planning for protected areas. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

Day, J.C., and J.C. Roff. 2000. Planning for representative marine protected areas: a framework for Canada's Oceans. Report prepared for World Wildlife Fund Canada, Toronto, Canada.

Dearden, P. 1997. Carrying capacity and environmental aspects of ecotourism. Pages 44-60 in J. Bornemeier, M. Victor, and P.B. Durst, editors. Ecotourism for forest conservation and community development. Proceedings of an international seminar, January 28-31, 1997, Bangkok, Thailand, RECOFTC Report 15 and RAP publication 1997/42, Regional Community Forestry Training Center, Kasetsart University, Bangkok, Thailand.

Dearden, P., and S. Chettamart. 1997. Development threats Asia's park, reserves. Forum for Applied Research and Public policy 12: 123-127.

Dearden, P., M. Theberge, and M. Bennett. 2002. Monitoring and marine park management at Koh Surin and Mu Koh Similan, Thailand. Pages 1283-1293 in S. Bondrup-Nielsen, N. Munro, G. Nelson, J.H. Willison, T.B. Herman, and P. Eagles, editors. Managing protected areas in a changing world. Proceedings of the Fourth International Conference on Science and Management of Protected Areas, 14-19 May 2000, Wolfville, Nova Scotia, Canada. Science and Management of Protected Areas Association, Nova Scotia, Canada.

Dearden, P., S. Chettamart, and D. Emphandu. 1998. Protected areas and property right in Thailand. Environmental Conservation 25: 195 –197.

Department of Conservation. 1994. Setting priority for the conservation of New Zealand's threatened plants and animals. Te Papa Atawhai, Wellington, New Zealand.

Diamond, J.M. 1975. The island dilemma: lessons of modern biogeographic for the design of natural reserves. Biological Conservation 7: 129-146.

Diamond, J.M., and R.M. May. 1981. Island biogeography and the design of nature reserve. Pages 228-252 in R.M. May, editor. Theoretical ecology: principles and applications. 2nd edition. Sinauer Associates, Inc. Sunderland, Massachusetts, U.S.A.

Dias, P.C. 1996. Sources and sinks in population biology. Trends in Ecology and Evolution 11: 326-330.

Dierberg, F.E., and W. Kiattisimkul. 1996. Issues, impacts, and implications of shrimp aquaculture in Thailand. Environmental Management 20: 649-666.

Dinerstein, E., and E.D. Wikramanayake. 1992. Beyond "hotspots": how to prioritize investments to conserve biodiversity in the Indo-Pacific region. Conservation Biology 7: 53-65.

Dixon, J.A., and P.B. Sherman. 1990. Economics of protected areas: a new look at benefits and costs. Island Press, Washington D.C., U.S.A.

Doak, D., and L.S. Mills. 1994. A useful role for theory in conservation. Ecology 75: 615-626.

Dobson, A.P., and J.P. Rodriguez. 2001. Discipline of conservation biology. Pages 855-863 in S.A. Levin, editor. Encyclopedia of biodiversity. Volume 1. Academic Press, San Diego, U.S.A.

Dudley, N., and B. Pressey. 2001. Forest protected areas: why should we worry about systematic planning. Arbortae (supplement), October 2001. WWF, United Kingdom and IUCN, Gland, Switzerland.

Dudley, N., and S. Stolton. 1998. Protected areas for a new millennium; the implications of IUCN's protected area categories for forest conservation. A joint IUCN and WWF discussion paper, IUCN, Gland, Switzerland.

Dudley, N., M. Hocking, and S. Stolton. 1999a. Measuring the effectiveness of protected areas management. Pages 249-257 in S. Stolton and N. Dudley, editors. Partnerships for protection: new strategies for planning and management for protected areas. Earthscan Publications, Limited, London, United Kingdom.

Dudley, N., B. Gujja, B. Jackson, J. Jeanrenaud, G. Oviedo, A. Philipps, P. Rosabel, S. Stolton, and S. Wells. 1999b. Challenges for protected areas in the 21st century. Pages 3-12 in S. Stolton and N. Dudley, editors. Partnerships for protection: new strategies for planning and management for protected areas. Earthscan Publications, Limited, London, United Kingdom.

Dulkul, P. 2001. Crowding norms in Thai national parks: a case study of Nam Tok Phrew National Park, Thailand. Unpublished thesis: Master of Parks, Recreation and Tourism Management, Lincoln University, New Zealand.

Durst, P.B., T.R. Waggener, T. Enters, and T.L. Cheng. 2001. Forest out of bounds: impacts and effectiveness of logging bans in natural forests in Asia-Pacific. FAO, RAP publication 2001/08. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

Eagles, P.F.J., and S.F. McCool, 2002. Tourism in national parks and protected areas: planning and management. CAB Publishing, United Kingdom.

Eagles, P.F.J., S.F. McCool, and C.D. Haynes. 2002. Sustainable tourism in protected areas: guideline for planning and management. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

Edge, W.D. 1993. Design and implementation of a workshop on the conservation and management of Thailand wildlife resources. Tigerpaper 20: 9-14.

Edmonds, R.L., J.K. Agee, and R.I. Gara. 2000. Forest health and protection. McGraw-Hill, New York, U.S.A.

Egan, A.F., S.B. Jones, A.E. Luloff, and J.C. Finley. 1995. The value of using multiple methods: an illustration using survey, focus group, and delphi techniques. Society and Natural Resources 8: 457-465.

Ehrlich, P.R. 1996. Conservation in temperate forests: what do we need to know and do? Forest Ecology and Management 85: 9-19.

Ehrlich, P.R., and C. Kremen. 2001. Human impacts on ecosystem: overview. Pages 383-393 in S.A. Levin, editor. Encyclopedia of biodiversity. Volume 3. Academic Press, San Diego, U.S.A

Emphandhu, D. 1992. Land use conflict and public participation as a conflict management tool in park management planning process: a case study of Doi Inthanon National Park in Thailand. Unpublished Ph.D. dissertation, University of Washington, U.S.A.

Ervin, J. 2000. The rapid assessment and prioritization of protected areas. Pages 277-292 in WWF: beyond the trees. An International Conference on the Design and Management of Forest Protected Areas. 8-11 May 2000, Bangkok, Thailand. WWF Forest for Life Campaign, the Royal Government of Thailand, and IUCN's World Commission on Protected Areas. Bangkok, Thailand.

Ervin, J. 2001. Improving protected area management: WWF's rapid assessment and prioritization methodology. WWF Forest for Life Programme, WWF International, Gland, Switzerland.

Fairbanks, D.H.K., B. Reyers, and A.S. van Jaarsveld. 2001. Species and environment representation: selecting reserves for the retention of avian diversity in KwaZulu-Natal, South Africa. Biological Conservation 98: 365-379.

Faith, D.P., and P.A. Walker. 1996. Integrating conservation and development incorporating vulnerability into biodiversity-assessment of areas. Biodiversity and Conservation 5: 417-429.

Falk, D.A., C.I. Millar, M. Olwell, editors. 1996. Restoring diversity: strategies for reintroduction of endangered plants. Island Press, Washington, D.C., U.S.A.

Fennell, D.A., and R.K. Dowling. 2003. Ecotourism policy and planning. CAB Publishing, United Kingdom.

Fimbel, R.A., A. Grajal, and G.R. Robinson, editors. 2001. The cutting edge: conservation wildlife in logged tropical forests. Columbia University Press, New York, U.S.A.

Fisher, R.J. 1995. Collaborative management of forests for conservation and development. IUCN and World Wild Fund for Nature, Gland, Switzerland.

Flaherty, M., and C. Karnjanakesorn. 1995. Marine shrimp aquaculture and natural resource degradation in Thailand. Environmental Management 19: 27-37.

Flaherty, M., and P. Vandergeest. 1998. "Low-Salt" shrimp aquaculture in Thailand: goodbye coastline, hello Khon Kaen! Environmental Management 22: 817-830.

Fleishman, E., B.G. Jonsson, and P. Sjogren-Gulve. 2000. Focal species modeling for biodiversity conservation. Ecological Bulletins 48: 85-99.

Forestry Research Center (FRC). 1995. A study on tourism for ecosystem conservation: a case study in southern Thailand. Faculty of Forestry, Kasetsart University, Bangkok, Thailand. (in Thai).

Forestry Research Center (FRC). 1997. Management plan: Khao Yai – Thap Lan – Pangsida – Ta Phraya National Parks. Faculty of Forestry, Kasetsart University, Bangkok, Thailand.

Fox, J., J. Krummel, S. Yarnasarn, M. Ekasingh, and N. Podger. 1995. Land use and landscape dynamics in northern Thailand: assessing change in three upland watersheds. Ambio 24: 328-334.

Franklin, J.F. 1989. Importance and justification of long-term studies in ecology. Pages 3-19 in G.E. Liken, editor. Long-term studies in ecology: approaches and alternatives. Spronger-Verlag, New York, U.S.A.

Franklin, J.F., C.S. Bledsoe, and J.T. Callahan. 1990. Contributions of the long-term ecological research program. BioScience 40: 509-523.

Freitag, S., A.O. Nicholls, and A.S. van Jaarsveld. 1998. Dealing with established reserve networks and incomplete distribution data sets in conservation planning. South African Journal of Science 94: 79-86.

Frumhoff, P.C., and E.C. Losos. 1998. Setting priorities for conserving biological diversity in tropical timber production forest. A policy report from the Union of Concerned Scientist, Cambridge, Massachusetts, and the Center for tropical Forest Science, Smithsonian Institute, Washington, D.C., U.S.A.

Galt, A., T. Sigaty, and M. Vinton, editors. 2000a. The World Commission on Protected Areas, 2nd Southeast Asia Regional Forum, Pakse, Lao PDR, 6-11 December 1999. Volume I–Executive Summary. IUCN, Vientiane, Lao PDR.

Galt, A., T. Sigaty, and M. Vinton, editors. 2000b. The World Commission on Protected Areas, 2nd Southeast Asia Regional Forum, Pakse, Lao PDR, 6-11 December 1999. Volume II–Papers Presented. IUCN, Vientiane, Lao PDR.

Geist, H.J., and E.F. Lambin. 2002. Proximate causes and underlying driving forces of tropical deforestation. BioScience 52: 143-150.

Gillis, M., and R. Repetto. 1988. Deforestation and government policy. International Center for Economic Growth, Panama, and Cambridge University Press, Massachusetts, U.S.A.

Gillis, M., and R. Repetto. 1993. Public policies and the misuse of forest resources. Pages 68-89 in S. Rietbergen, editor. The Earthscan reader in tropical forestry. Earthscan Publication Limited, London, United Kingdom.

Gilpin, M.E., and M.E. Soulé. 1986. Minimum viable population: process of species extinction. Pages 19-34 in M.E. Soulé, editor. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Inc., Sunderland, Massachusetts, U.S.A.

Given, D.R. 1993. What is conservation biology and why it is so important? Journal of the Royal Society of New Zealand 23: 55-60.

Goldsmith, B., editor. 1991. Monitoring for conservation and ecology. Chapman and Hall, London, United Kingdom.

Good, J.W., J.W. Weber, J.W. Charland, J.V. Olson, and K.A. Chapin. 1998. National coastal zone management effectiveness study: protecting estuaries and coastal wetlands. Final report to the Office of Ocean and Coastal Resources Management, National Oceanic and Atmospheric Administration. Oregon State Grant Special Report PI-98-001, Corvallis, Oregon, U.S.A.

Graefe, A., F.R. Kuss, and J.J. Vaske. 1990. Visitor impact management: the planning framework. National Park and Conservation Association, Washington, D.C., U.S.A.

Grainger, A., S. Rose, Y. Trisurat, and W. Brockelman. 1995. A GIS approach to mapping spatial variation in tropical rain forest biodiversity. Pages 335-353 in B. Boyle and B. Boontawee, editors. Measuring and monitoring biodiversity in tropical and temperate forests. Proceedings of a IUFRO symposium, August 27- September 2, 1994, Chiang Mai, Thailand. Center for International Forestry Research (CIFOR), Bogor, Indonesia.

Gray, G.J., L. Fisher, and L. Jungwirth. 2001. An introduction to community-based ecosystem management. Journal of Sustainable Forestry 12: 25-34.

Green, J.B., M.G. Murray, G.C. Bunting, and J.R. Paine. 1997. Priorities for biodiversity conservation in the tropics. WCMC, Biodiversity Bulletin No.1. Cambridge, United Kingdom.

Green, M.J.B., and J. Paine. 1998. State of the world's protected areas at the end of the twentieth century. Paper presented at the IUCN World Commission on Protected Areas Symposium on Protected Areas in the 21st Century: from islands to networks, 24-29 November 1997, Albany, Australia.

Green, M.J.B., and J. Paine. 1999. State of the world's protected areas at the end of the 20th century. Pages 18-28 in S. Stolton and N. Dudley, editors. Partnerships for protection: new strategies for planning and management for protected areas. Earthscan Publications, Limited, London. United Kingdom.

Groves, C.R. 2003. Drafting a conservation blueprint: a practitioner's guide to planning for biodiversity. The Nature Conservancy and Island Press, Washington, D.C., U.S.A.

Groves, C.R., D.B. Jensen, L.L. Valutis, K.H. Redford, M.L. Shaffer, J.M. Scott, J.V. Baumgartner, J.V. Higgins, M.W. Beck, and M.G. Anderson. 2002. Planning for biodiversity conservation: putting conservation science into practice. BioScience 52: 499-512.

Gullison, T, M. Melnyk, and C. Wong. 2001. Logging off: mechanism to stop or prevent industrial logging in forest of high conservation value. Union of Concerned Scientist, Cambridge, Massachusetts, and the Center for tropical Forest Science, Smithsonian Institute, Washington, D.C., U.S.A.

Gustanski, J.A., and R.H. Squires, editors. 2000. Protecting the land: conservation easements past, present, and future. Island Press, Washington, D.C., U.S.A.

Hansen, A.J., T.A. Spies, F.J. Sawanson, and J.L. Ohmann. 1991. Conserving biodiversity in managed forest. BioScience 41: 382-392.

Hansen, A.J., J.J. Rotella, M.P.V. Kraska, and D. Brown. 1999. Dynamic habitat and population analysis: an approach to resolve the biodiversity manager's dilemma. Ecological Applications 9:1459-1476.

Hanski, I. 1991. Metapopulation dynamics: brief history and conceptual domain. Biological Journal of the Linnean Society 42: 3-16.

Hanski, I. 1999a. Habitat connectivity, habitat continuity, and metapopulations in dynamic landscapes. Oikos 87: 209-219.

Hanski, I. 1999b. Metapopulation ecology. Oxford University Press, Oxford, New York, U.S.A.

Hansson, L. 2001. Indicators of biodiversity: recent approaches and some general suggestions. Ecological Bulletins 50: 223-229.

Harmon, D. 1994. Coordinating research and management to enhance protected areas. IUCN, George Wright Society, the Science and Management of Protected Area Association, and the Commission of the Europe Union. Weber and Sons, Inc., Wisconsin, U.S.A.

Harrison, S. 1991. Local extinction in a metapopulation context: an empirical evaluation. Biological Journal of the Linnean Society 42: 73-88.

Haskell, B.D., B.G. Norton, and R. Costanza. 1992. What is ecosystem health and why should we worry about it? Pages 3-19 in R. Costanza, B.G. Norton, and B.D. Haskell, editors. Ecosystem health: new goals for environmental management. Island Press, Washington, D.C., U.S.A.

Hastings, A., and S. Harrison. 1994. Metapopulation dynamics and genetics. Annual Review of Ecology and Systematics 25: 167-188.

Haufler, J.B. 1999. Strategies for conserving terrestrial biological diversity. Pages 17-34 in R. K. Baydack, H.C. Campa III, and J.B. Haufler, editors. Practical approaches to the conservation of biological diversity. Island Press, Washington, D.C., U.S.A.

Hawkes, J.G., N. Maxted, and B.V. Ford-Lloyd, editors. 2000. The ex situ conservation of plant genetic resources. Kluwer Academic Publishers, Dordrecht, Netherlands.

Hawthorn, D., M. Keeri, and P.F.J. Eagles. 2002. Evaluating management effectiveness of parks and park systems: a proposed methodology. Pages 414- 430 in S. Bondrup-Nielsen, N. Munro, G. Nelson, J.H. Willison, T.B. Herman, and P. Eagles, editors. Managing protected areas in a changing world. Proceedings of the Fourth International Conference on Science and Management of Protected Areas, 14-19 May 2000, Wolfville, Nova Scotia, Canada. Science and Management of Protected Areas Association, Nova Scotia, Canada.

Hershman, M.J., J.W. Good, T. Bernd-Cohen, R.F. Goodwin, V. Lee, and P. Pogue. 1999. The effectiveness of coastal management in the United States. Coastal Management 27:113-138.

Hobbs, R.J. 1988. What is ecological theory and is it of any use to managers? Pages 15-27 in D. Saunders and A.A. Burbidge, editors. Ecological theory and biological management of ecosystems. Occasional Paper No. 1/88. Department of Conservation and Land management, Western Australian Wildlife Research Centre, Wanneroo, Western Australia, Australia.

Hockings, M. 1997. Evaluating management effectiveness: a framework for evaluating management of protected areas. Draft for discussion, IUCN World Commission on Protected Areas, Working Group on Management Effectiveness.

Hockings, M. 1998. Evaluating management of protected areas: integrating planning and evaluation. Environmental Management 22: 337-345.

Hockings, M. 2000. Evaluating protected area management: a review of systems for assessing management effectiveness of protected areas. Occasional paper, volume 7, no.3, School of Natural and Rural Systems Management, The University of Queensland, Queensland, Australia.

Hockings, M., and K. Twyford. 1997. Assessment and management of beach camping impact within Frazer Island World Heritage Area, South-east Queensland. Australian Journal of Environmental Management 4: 26-39.

Hockings, M., S. Stolton, and N. Dudley. 2000. Evaluating effectiveness: a framework for assessing management of protected areas. World Commission on Protected Areas, Best practice protected area guidelines series no.6, IUCN, Gland, Switzerland and Cardiff University, United Kingdom.

Hockings, M., S. Stolton, and N. Dudley. 2002. Evaluating effectiveness: a summary for park managers and policy makers. WWF, United Kingdom and IUCN, Gland, Switzerland.

Hof, M., and D.W. Lime. 1997. Visitor experience and resource protection Framework in the national park system: rationale, current status, and future direction. Pages 29-36 in S.F. McCool, and D.N. Cole, compilers. Proceedings- Limits of acceptable change and related planning processes: progress and future directions. A workshop held at the University of Montana's Lubrecht Experimental Forest, May 20-22, 1997, Missoula, Montana. USDA Forest Service, Rocky Mountain Research Station, General Technical Report: INT-GTR- 371, Ogden, Utah, U.S.A.

Howard, P.C., P. Viskanic, T.R.B. Davenport, F.W. Kigenyi, M. Baltzer, C.J. Dickinson, J.S. Lwanga, R.A. Matthews, and A. Balmford. 1998. Complementarity and the use of indicator groups for reserve selection in Uganda. Nature 394: 472-475.

Hunter, M.L. 1988. Paleoecology and the coarse-filter approach to maintain biological diversity. Conservation Biology 2: 375-385.

Hunter, M.L. 1996. Fundamentals of conservation biology. Blackwell Science, Cambridge, Massachusetts, U.S.A.

Hunter, M.L, editor. 1999. Maintaining biodiversity in forest ecosystems. Cambridge University Press, Cambridge, Massachusetts, U.S.A.

Hunter, M.L., G.L. Jacobson, and T. Webb. 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. Conservation Biology 2: 375-385.

Innes, J.L. 1993. Methods to estimate forest health. Silva Fennica 27: 145-157.

IUCN. 1979a. Conservation for Thailand – policy guidelines. Volume I: policy guidelines. Morges, Switzerland.

IUCN. 1979b. Conservation for Thailand – policy guidelines. Volume II: appendices. Morges, Switzerland.

IUCN. 1981. Conserving Africa's natural heritage: the planning and management of protected areas in the Afrotropical realm. Proceedings of the 17th Meeting of IUCN's Commission on National Parks and Protected Areas, Garoua, Cameroon, 17-23 November 1980. IUCN, Gland, Switzerland.

IUCN. 1994. Guidelines for protected area management categories. Commission on National Parks and Protected Areas (CNPPA) with the assistance of WCMC, IUCN, Gland, Switzerland and Cambridge, United Kingdom.

IUCN. 1998. Protected areas in the 21st century: from islands to networks. Conference report, IUCN World Commission on Protected Areas, 24-29 November 1997, Albany, Western Australia. Draft of 6 January 1998.

IUCN. 1999. Management effectiveness: the case of world natural heritage. Summary of an international workshop. Report on the management effectiveness meeting at the Broads, United Kingdom. September 1999. The World Commission on Protected Areas Task Force on Management Effectiveness with the World Heritage Bureau and The IUCN/WWF Forest Innovation Project.

IUCN. 2000. Management effectiveness of protected areas- an international workshop. IUCN and WWF International. Gland, Switzerland.

IUCN. 2001. IUCN red list categories and criteria: version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, United kingdom.

IUCN. 2002. Protected areas development in the lower Mekong River region. Also available from http://www.mekong-protected-areas.org/thailand/round1.htm (accessed 23 September 2002).

Ives, J.D., S. Sabhasri, and P. Voraurai, editors. 1980. Conservation and development in Northern Thailand. Proceedings of a Programmatic Workshop on Agro-Forestry and Highland-Lowland Interactive Systems, 13-17 November 1978, Chiang Mai, Thailand. The United Nation University, Shibuya-Ku, Tokyo, Japan.

Jaffre, T., P. Bouchet, and J. Veillon. 1998. Threatened plants of New Caledonia: is the system of protected areas adequate? Biodiversity and Conservation 7: 109- 135.

Jennings, M. D. 2000. Gap analysis: concepts, methods, and recent results. Landscape Ecology 15:5-20.

Jepson, P., F. Momberg, and H. van Noord. 2002. A review of the efficacy of the protected area system of East Kalimantan province, Indonesia. Natural Areas Journal 22: 28-42.

Jintanugool, J. 1992. Nature and wildlife conservation in Thailand. Wildlife Conservation Division, Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand. Unpublished document (in Thai).

Jintanugool, J., A.A. Eudey, and W.Y. Brockelman. 1982. Species conservation priorities in Thailand. Pages 41-51 in R.A. Mittermeier and W.R. Konstant, editors. Species conservation priorities in the tropical forests of Southeast Asia. Proceedings of a Symposium held at the 58th Meeting of the IUCN Species Survival Commission (SSC), October 4, 1982, Kuala Lumpur, Malaysia. Occasional Papers of the IUCN Species Survival Commission, No.1, IUCN, Grand, Switzerland.

Johnson, N.C. 1995. Biodiversity in the balance: approaches to setting geographic conservation priorities. Biodiversity support program, WWF, Washington, D.C. U.S.A.

Jones, G. 2000. Outcomes-based evaluation of management for protected areas – a methodology for incorporating evaluation into management plan. Pages 349-358 in WWF: beyond the trees. An International Conference on the Design and Management of Forest Protected Areas. 8-11 May 2000, Bangkok, Thailand. WWF Forest for Life Campaign, the Royal Government of Thailand, and IUCN's World Commission on Protected Areas. Bangkok, Thailand.

Kanjana, N. 2000. Basic physical and biological information of wildlife sanctuaries of Thailand. Wildlife Conservation Division, Royal Forest Department, Bangkok, Thailand. (in Thai with English abstract).

Kareiva, P., and M. Marvier. 2003. Conserving biodiversity coldspots. American Scientist 91: 344-351.

Karr, J.K., and E.W. Chu. 1995. Ecological integrity: reclaiming lost connections. Pages 34-48 in L. Westra and J. Lemons, editors. Perspectives on ecological integrity. Kluwer Academic Publishers, Dordrecht, Netherlands.

Karr, J.R. 1992. Ecological integrity: protecting earth's life support systems. Pages 223-237 in R. Costanza, B.G. Norton, and B.D. Haskell, editors.

Ecosystem health: new goals for environmental management. Island Press, Washington, D.C., U.S.A.

Karr, J.R. 1995. Using biological criteria to protect biological health. Pages 137-152 in D.J. Rapport, C.L. Gaudet, and P. Calow, editors. 1995. Evaluating and monitoring the health of large-scale ecosystems. NATO ASI Series Volume 128. Springer Verlag, Berlin, Germany.

Karr, J.R. 2000. Health, integrity, and biological assessment: the importance of measuring whole things. Pages 209-226 in D. Pimentel, L. Westra, and R.F. Noss, editors. Ecological integrity: integrating environment, conservation, and health. Island Press, Washington, D.C., U.S.A.

Kasetsart University (KU). 1987. Assessment of national parks, wildlife sanctuaries and other preserves development in Thailand. Final report, Faculty of Forestry, Kasetsart University, Royal Forest Department, and Office of the National Environment Board, Bangkok, Thailand.

Kelleher, G. 1999. Guidelines for marine protected areas. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

Khan, M.L., S. Menon, and K.S. Bawa. 1997. Effectiveness of the protected area network in biodiversity conservation: a case study of Meghalaya state. Biodiversity and Conservation 6: 853-868.

Kimmins, J.P. 1996. The health and integrity of forest ecosystems: are they threatened by forestry. Ecosystem Health 2: 5-18.

Kitching, I.J. 1996. Identify complementary areas for conservation in Thailand: an example using owls, hawkmoths and tiger beetles. Biodiversity and Conservation 5: 841-858.

Kleiman, D.G., R.P. Reading, B.J. Miller, T.W. Clark, J.M. Scott, J. Robinson, R.L. Wallace, R.J. Cabin, and F. Felleman. 2000. Improving the evaluation of conservation programs. Conservation Biology 14: 356-365.

Kolb, T.E., M.R. Wagner, and W.W.Covington. 1994. Concepts of forest health. Journal of Forestry 92: 10-15.

Kramer, R., C. van Schaik, and J. Johnson, editors. 1997. Last stand: protected areas and the defense of tropical biodiversity. Oxford University Press, New York, U.S.A.

Kremen, C., A.M. Merenlender, and D.D. Murphy. 1994. Ecological monitoring: A vital need for integrated conservation and programs in the tropics. Conservation Biology 8: 388-397.

Kremen, C., I. Raymond, and K. Lances. 1998. An interdisciplinary tool for monitoring conservation impacts in Madagascar. Conservation Biology 12: 549-563.

Kremen, C., V. Razafimahatratra, R.P. Guillery, J. Rakotomala, A. Weiss, and J. Ratsisompatrarivo. 1999. Designing the Masoala National Park in Madagascar based on biological and socioeconomic data. Conservation Biology 13: 1055-1068.

Kremen, C., D. Lees, V. Razafimahatratra, and H. Raharitsimba. 2001. Designing a new national park in Madagascar. Pages 400-428 in W. Weber, L.T. White, A. Vedder, and L.Naughton-Treves, editors. African rain forest ecology and conservation: an interdisciplinary perspective. Yale University Press, New Haven, U.S.A.

Kress, W.J., W.R. Heyer, P. Acevedo, J. Coddington, D. Cole, T.L. Erwin, B.J. Meggers, M. Pogue, R.W. Thorington, R.P. Vari, M.J. Weitzman, and S.H. Weitzman. 1998. Amazonian biodiversity: assessing conservation priority with taxonomic data. Biodiversity and Conservation 7: 1577-1587.

Kunstadter, P., E.C. Chapman, and S. Sabhasri, editors. 1978. Farmer in the forest: economic development and marginal agriculture in Northern Thailand. East-West Center Population Institute, East-West Center, The University Press of Hawaii, Honolulu, Hawaii, U.S.A.

Kunstadter, P., and S. Sabhasri, editors. 1986. Man in the mangroves: the socio-economic situation of human settlements in mangrove forests. Proceedings of a workshop held at Nong Nuch Village, Pattaya, Thailand. The United Nation University and the National Research Council of Thailand. The United Nation University, Shibuya-ku, Tokyo, Japan.

Kutintara, U. 1994a. Wildlife resource policy and administration. Department of Forest Biology, Kasetsart University, Bangkok, Thailand. Unpublished document (in Thai).

Kutintara, U. 1994b. Administration and management of wildlife conservation areas. Department of Forest Biology, Kasetsart University, Bangkok, Thailand. Unpublished document (in Thai).

Laird, S.A, editor. 2002. Biodiversity and traditional knowledge: equitable partnerships in practice. Earthscan Publications Limited, London, United Kingdom.

Lambeck, R.J. 1997. Focal species: a multi-species umbrella for nature conservation. Conservation Biology 11: 849-856.

Landres, P.B., J. Verner, and J.W. Thomas. 1988. Ecological uses of vertebrate indicator species: a critique. Conservation Biology 2: 316-220.

Landres, P.B., P. Morgan, and F.J. Swanson. 1999. Overview of the use of natural variability concepts in managing ecological systems. Ecological Applications 9: 1179-1188.

Laurance, W.F., and R.O. Bierregaard, Jr., editors. 1997. Tropical forest remnants: ecology, management, and conservation of fragmented communities. The University of Chicago Press, Chicago, U.S.A.

Lawton. J.H., and K.J. Gaston. 2001. Indicator species. Pages 437-450 in S.A. Levin, editor. Encyclopedia of biodiversity. Volume 3. Academic Press, San Diego, U.S.A.

Leader-Williams, N., J. Harrison, and M.J.B. Green. 1990. Designing protected areas to conserve natural resources. Science Progress 74: 189-204.

Lewicki, R.J., B. Gray, and M. Elliott, editors. 2003. Making sense of intractable environmental conflicts: frame and cases. Island Press, Washington, D.C., U.S.A.

Lindenmayer, D.B., R.B. Cunningham, C.F. Donnelly, and R. Lesslie. 2002. On the use of landscape surrogates as ecological indicators in fragmented forests. Forest Ecology and Management 159: 203-216.

Linder, H.P. 1994. Setting conservation priority: the importance of endemism and phylogeny in the southern African Orchid genus *Herschelia*. Conservation Biology 8: 585-595.

Liu, J., M. Linderman, Z. Ouyang, L. An, J. Yang, and H. Zhang. 2001. Ecological degradation in protected areas: the case of Wolong Nature Reserve for Giant Pandas. Science 292: 98-101.

Lombard, A.T., R.M. Cowling, R.L. Pressey, and A.G. Rebelo. 2003. Effectiveness of land classes as surrogates for species in conservation planning for the Cape Floristic Region. Biological Conservation 112: 45-62.

Loomis, J.B. 2002. Integrated public lands management: principles and applications to national forests, parks, wildlife refuges, and Bureau of Land Management (BLM) lands. Columbia University Press, New York, U.S.A.

Lubchenco, J., S. R. Palumbi, S.D. Gaines, and S. Andelman. 2003. Plugging a hole in the ocean: the emerging science of marine reserves. Ecological Applications 13: S3-S7.

MacArthur, R.H., and E. O. Wilson. 1967. The theory of island biogeography. Princeton University Press. Princeton, New Jersey, U.S.A.

Mackey, B.G., H.A. Nix, M.F. Hutchinson, J.P. Mcmahon, and P. M. Fleming. 1988. Assessing representativeness of place for conservation reservation and heritage listing. Environmental Management 12: 501-514.

MacKinnon, J. 1997. Protected areas systems review of the Indo-Malayan realm. The Asian Bureau for Conservation, the World Bank, and The World Conservation Monitoring Center. The Asian Bureau for Conservation Limited, Canterbury, United Kingdom.

MacKinnon, J., and K. MacKinnon. 1986. Review of the protected areas system in the Indo-Malayan Realm. IUCN, CNPPA, and UNEP. Gland, Switzerland and Cambridge, United Kingdom.

MacKinnon, J., K. Mackinnon, G. Child, and J. Thorsell. 1986. Managing protected areas in the tropics. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

Mackinnon, K. 1997. The ecological foundations of biodiversity protection. Pages 36-63 in R. Kramer, C. van Schaik, and J. Johnson, editors. Last stand: protected areas and the defense of tropical biodiversity. Oxford University Press, New York, U.S.A.

MacKinnon, K. 2001. Editorial: integrated conservation and development project. Park 11: 1-4.

MacKinnon, K., and W. Wardojo. 2001. ICDP: imperfect solutions for imperiled forests in South-East Asia. Park 11: 50-59.

Maehr, D.S., R.F. Noss, and J.L. Larkin. 2001. Large mammal restoration: ecological and sociological challenges in the 21st century. Island Press, Washington, D.C., U.S.A.

Marcot, B.G., and D.D. Murphy. 1996. On population viability and management. Pages 58-76 in R.C. Szaro and D.W. Johnston, editors. Biodiversity in managed landscapes: theory and practice. Oxford University Press, New York, U.S.A.

Marine National Park Division (MNPD). 2000a. Criteria for park selection. Marine National Park Division, Natural Resources Conservation Office, Royal Forest Department, Bangkok, Thailand. (in Thai). Also available from http://www.forest.go.th/park/sara/manage/select.htm (accessed 21 September 2000).

Marine National Park Division (MNPD). 2000b. Steps in park establishment. Marine National Park Division, Natural Resources Conservation Office, Royal Forest Department, Bangkok, Thailand. (in Thai). Also available from http://www.forest.go.th/park/sara/manage/step.htm (accessed 21 September 2000).

Margules, C.R., and M.P. Austin, editors. 1991. Nature conservation: cost Effective biological surveys and data analysis. Commonwealth Scientific and Industrial Research Organization (CSIRO), Canberra, Australia.

Margules, C.R., R.L. Pressey, and A.O. Nicholls. 1991. Selecting nature reserves. Pages 90-97 in C.R. Margules and M.P. Austin, editors. Nature conservation: cost effective biological surveys and data analysis. CSIRO, Canberra, Australia.

Margules, C.R., I.D. Cresswell, and A.O. Nicholls. 1994. A scientific basis for establishing networks of protected areas. Pages 327-350 in P.L. Forey, C.J. Humphries, and R.I. Vane-Wright, editors. Systematics and conservation evaluation. Clardendon Press, Oxford , New York, U.S.A.

Margules, C.R., and R.L. Pressey. 2000. Systematic conservation planning. Nature 405: 243-253.

Mascia, M.B. 2001. Designing effective coral reef marine protected areas. A synthesis report based on presentations at the 9th international coral reef symposium, Bali, Indonesia, October 2000. Special report to IUCN World

Commission on Protected Areas-Marine, April 2001, IUCN, Gland, Switzerland.

Maser, C. 1990. On the natural ness of natural areas: a perspective for the future. Natural Areas Journal 10: 129-133.

Maxted, N. 2001. Ex situ, in situ conservation. Pages 683-695 in S.A. Levin, editor. Encyclopedia of biodiversity. Volume 2. Academic Press, San Diego, U.S.A.

Maxted, N., B.V. Ford-Lloyd, and J.G. Hawkes, editors. 1997. Plant genetic conservation: the in situ approach. Chapman and Hall, London, United Kingdom.

McNeely, J.A. 1995. Expanding partnerships in conservation. IUCN World Conservation Union. Island Press Washington, D.C., U.S.A.

McNeely, J.A. 1996. Assessing methods for setting conservation priority. A paper presented to OECD Conference on Biodiversity, Cairns, Australia.

McNeely, J.A. 2000. Coping with the unexpected: challenges and opportunities for protected area management in Southeast Asia at the turn of the century. Pages 25-32 in A. Galt, T. Sigaty, and M. Vinton, editors. World Commission on Protected Areas, 2nd Southeast Asia Regional Forum, Pakse, Lao PDR, 6-11 December 1999. Volume II – Papers Presented. IUCN, Vientiane, Lao PDR.

McNeely, J.A., and R.J. Dobias. 1991. Economic incentives for conserving biodiversity in Thailand. Ambio 20: 86-90.

McNeely, J.A., and S. Somchevita, editors. 1996. Biodiversity in Asia: challenges and opportunities for the scientific community. Proceedings of a Conference on Prospects of Cooperation on Biodiversity Activities, Chiang Rai, Thailand, 15-19 January 1996. Office of Environmental Policy and Planning, Ministry of Science, Technology and Environment, Bangkok, Thailand.

McQuistan, C. 1999. Country profile – Thailand. ITTO Newsletter 9: 21. Also available from http://www.itto.or.jp/newsletter/v9n1/21.html (accessed 13 July 1999).

Menge, B.A., and T.L. Freidenburg. 2001. Keystone species. Pages 613-631 in S.A. Levin, editor. Encyclopedia of biodiversity. Volume 3. Academic Press, San Diego, U.S.A.

MIDAS. 1993. Conservation forest area protection, management, and development project: Pre-investment study. Global Environmental Facility: the World Bank, United Nations Development Program, Ministry of Agriculture and Cooperatives. Draft Final Report, Volume No.2. Bangkok, Thailand.

Miller, B., R. Reading, J. Strittholt, C. Carroll, R. Noss, M. Soule, O. Sanchez, J. Terborgh, D. Brightsmith, T. Cheeseman, and D. Foreman. 1998. Using focal species in the design of nature reserve networks. Wild Earth 8: 81-85, 88-92.

Miller, K R. 1999. Bioregional planning and biodiversity conservation. Pages 41-49 in S. Stolton and N. Dudley, editors. Partnerships for protection: new strategies for planning and management for protected areas. Earthscan Publications, Limited, London, United Kingdom.

Mills, L., M.E. Soule, and D.F. Doak. 1993. The keystone-species concept in ecology and conservation. BioScience 43: 219-224.

Ministry of Natural Resources and Environment (MONRE). 2003. Ministry of Natural Resources and Environment. Also available from http://www.monre.go.th (accessed 29 May 2003).

Mondor. C. 1990. The concept of representativeness in the design of protected areas systems. A paper presented to the workshop on representivity Canadian Council on Ecological Areas, 1990 Annual Meeting, Minto Place Hotel, Ottawa, Ontario, September 27-30, 1990. National Parks Service, Environmental Canada, Ottawa, Ontario, Canada.

Morgan, P., G.H. Aplet, J.B. Haufler, H.C. Humphries, M.M. Moore, and W.D.Wilson. 1994. Historical range of variability: a useful tool for evaluating ecosystem change. Pages 87-112 in R.N. Sampson and D. L. Adams, editors. Assessing forest ecosystem health in the inland west. The Haworth Press, Inc., New York, U.S.A.

Morrison, M.L. 2002. Wildlife restoration: techniques for habitat analysis and animal monitoring, Island Press, Washington, D.C., U.S.A.

Myers, N. 1997. The world's forests and their ecosystem services. Pages 215-235 in G.C. Daily, editor. Nature's service: societal dependence on natural ecosystems. Island Press. Washington, D.C., U.S.A.

Myers, N. 2001. Hotspots. Pages 371-381 in S.A. Levin, editor. Encyclopedia of biodiversity. Volume 3. Academic Press, San Diego, U.S.A.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853-858.

Nair, C.T.S., T. Enters, and B. Pyne. 1995. Report on the workshop on barriers to the application of forestry research results. CIFOR Occasional paper no.5, CIFOR, Bogor, Indonesia.

Nelson, J.G., J.C. Day, and L.M. Sportza, editors. 2003. Protected areas and the regional planning imperative in North America: integrating nature conservation and sustainable development. University of Calgary, Canada and Michigan State University Press, U.S.A.

Newmark, W.D., and J.L. Hough. 2000. Conserving wildlife in Africa: integrated conservation and development projects and beyond. BioScience 50: 585-592.

Ngamcharoen, C. 2001. Community forestry in the Royal Forest Department. RFD, Bangkok, Thailand. (Personal communication).

Nillson, C., and F. Gotmark. 1992. Protected areas in Sweden: is natural variety adequately represented? Conservation Biology 6: 232-242.

Nilsen, P., and G. Tayler. 1997. A comparative analysis of protected area planning and management frameworks. Pages 49-57 in S.F. McCool, and D.N. Cole, compilers. Proceedings- Limits of Acceptable Change and related planning processes: progress and future directions. A workshop held at the University of Montana's Lubrecht Experimental Forest, May 20-22, 1997, Missoula, Montana. USDA Forest Service, Rocky Mountain Research Station, General Technical Report: INT-GTR- 371, Ogden, Utah, U.S.A.

Noon, B.R. 2003. Conceptual issues in monitoring ecological resources. Pages 27-71 in D.E. Busch, and J.C. Trexler, editors. 2003. Monitoring ecosystems: interdisplinary approaches for evaluating ecoregional initiatives. Island Press, Washington, D.C., U.S.A.

Noon, B.R., T.A. Species, and M.G. Raphael. 1999. Conceptual basis for designing an effectiveness monitoring program. Pages 21-48 in B.S. Mulder, B.R. Noon, T.A. Spcies, M.G. Raphael, C.J. Palmer, A.R. Olsen, G.H. Reeves, and H.H. Welsh, editors. The strategy and design of the effectiveness monitoring program for the Northwest Forest Plan. USDA Forest Service, Pacific Northwest Research Station, General Technical Report (PNW-GTR-437), Portland, Oregon, U.S.A.

Nootong, T. 2000. Protected area management in Thailand. Pages 84-88 in A. Galt, T. Sigaty, and M. Vinton, editors. The World Commission on Protected Areas, 2nd Southeast Asia Regional Forum, Pakse, Lao PDR, 6-11 December 1999. Volume II–Papers Presented. IUCN, Vientiane, Lao PDR.

Noss, R.F. 1990. Indicators for monitoring biodiversity: a hierarchical approach. Conservation Biology 4: 355-364.

Noss, R.F. 1995. Ecological integrity and sustainability: buzzwords in concept? Pages 60-76 in L. Westra and J. Lemons, editors. Perspectives on ecological integrity. Kluwer Academic Publishers, Dordrecht, Netherlands.

Noss, R.F. 1996. Protected areas: how much is enough? Pages 91-120 in R.G. Wright, editor. National parks and protected areas: their role in environmental protection. Blackwell Science, Cambridge, Massachusetts. U.S.A.

Noss, R.F. 1999. Assessing and monitoring forest biodiversity: a suggested framework and indicators. Forest Ecology and Management 115: 135-146.

Noss, R.F., and A.Y. Cooperrider. 1994. Saving Nature's Legacy. Island Press, Washington, D.C., U.S.A.

Noss, R.F., M.A. O'Connell, and D.D. Murphy. 1997. The science of conservation planning: habitat conservation under the Endangered Species Act. Island Press, Washington, D.C., U.S.A.

Noss, R.F., N.C. Slosser, J.R. Strittholt, and C. Carroll. 1999. Some thoughts on metrics of ecological integrity for terrestrial ecosystems and entire landscapes. Conservation Biology Institute, Corvallis, Oregon, U.S.A.

Noss, R.F., C. Carrol, K. Vance-Borland, and G. Wuerthner. 2002. A multicriteria assessment of the irreplaceability and vulnerability of site in the Greater Yellowstone Ecossytem. Conservation Biology 16: 895-908.

NPS. 1986. Planning for ASEAN heritage parks and reserves. A report submitted to Association of Southeast Asian Nations Experts Group on the Environment (ASEAN/AEGE) and UNEP. International Park Affairs, National Park Service (NPS), United States Department of the Interior, U.S.A. and Bangkok, Thailand.

NPS. 1988. Management policies. National Park Service, United States Department of the Interior, U.S.A.

NPS. 1995. Natural resource inventory and monitoring guideline. NPS-75. National Park Service, United States Department of the Interior, U.S.A.

NPS. 1999. Criteria for parklands: resource topics for parklands. Division of Park Planning and Protection, National Park Service, U.S. Department of the Interior. Washington, D.C., U.S.A. Also available from http://www.nps.gov/legacy/criteria.htm (accessed 17 July 2000).

NPS. 2000. Management Policies 2001. U.S. Department of the Interior. Washington, D.C., U.S.A.

Oldfield, S., editor. 2003. The trade in wildlife: regulation for conservation. Earthscan Publications, Limited, London, United Kingdom.

Ongprasert , P. 2001. Community forestry in the Royal Forest Department. RFD, Bangkok, Thailand. (Personal communication).

Office of Environmental Policy and Planning (OEPP). 2003. The policy and prospective plan for enhancement and conservation of national environmental quality 1997-2016. Also available from http://www.oepp.go.th/eng/policy_1.html (accessed 6 March 2003).

Panayotou, T., and S. Sungsuwan. 1989. An econometric of the causes of tropical deforestation: the case of northeast Thailand. Development Discussion Paper No. 284. Harvard Institute for International Development, Harvard University, Cambridge, Massachusetts, U.S.A.

Panyapornvittaya, A. 2001. Cabinet resolution and conflict resolution in protected areas in Thailand. Office of the Secretary, Royal Forest Department, Bangkok, Thailand. (Personal communication).

Park, Wildlife and Plant Conservation Department (PWPCD). 2003. Park, Wildlife and Plant Conservation Department. Also available from http://www.nationalpark.go.th (accessed May 29, 2003).

Park Canada. 1999. National park policy: parks Canada guiding principles and operational policies. Park Canada National Office, Quebec, Canada. Also available from http://parkscanada.pch.gc.ca/library/PC_Guiding_Principles/ Park34_e.htm (accessed 29 July 2000).

Parr, J. 1996. Evaluating conservation areas in Thailand. Tigerpaper 23: 1-4.

Pattanavibool, A. 1993. Influence of forest management practices on cavity resources in mixed deciduous forests in Thailand. Unpublished Master Thesis, Oregon State University, Corvallis, Oregon, U.S.A.

Pattanavibool, A. 1999. Wildlife response to habitat fragmentation and other human influences in tropical montane evergreen forests, northern Thailand. Unpublished Ph.D. dissertation, University of Victoria, Canada.

Pattanavibool, A. 2000.Thung Yai – Huai Kha Kaeng. The first natural world heritage site for mainland Southeast Asia: what it was and still is. Pages 420-421 in A. Galt, T. Sigaty, and M. Vinton, editors. World Commission on Protected Areas, 2nd Southeast Asia Regional Forum, Pakse, Lao PDR, 6-11 December 1999. Volume II–Papers Presented. IUCN, Vientiane, Lao PDR.

Pattanavibool, A., and W. D. Edge. 1996. Single-tree selection silviculture affects cavity resources in mixed deciduous forest in Thailand. Journal of Wildlife Management 60: 67-73.

Pattanavibool, A., and P. Deardren. 2002. Fragmentation and wildlife in montane evergreen forests, northern Thailand. Biological Conservation 107: 155-164.

Pattanavibool, A., T. Nakornchai, S. Vinitpornsawan, and N. Khewwan. 2002. Wildlife rapid ecological assessment technique manual. Western Forest Complex Ecosystem Management (WEFCOM) Project, Royal Forest Department, Bangkok, Thailand. (in Thai).

Perrow, M.R., and A. J. Davy, editors. 2002a. Handbook of ecological restoration. Volume 1: Principles of restoration, Cambridge University Press, New York, U.S.A.

Perrow, M.R., and A. J. Davy, editors. 2002b. Handbook of ecological restoration. Volume 2: Restoration in practice, Cambridge University Press, New York, U.S.A.

Perry, D.A. 1994. Forest ecosystem. The Johns Hopkins University Press, Baltimore, Maryland, U.S.A,U.S.A.

Peterson, A.T., S.L. Egbert, V. Sanchez-Cordero, and K.P. Price. 2000. Geographic analysis of conservation priority: endemic bird and mammals in Veracruz, Mexico. Biological Conservation 93:8 -94.

Peterson, C.H., and J. Lubchenco. 1997. Marine ecosystem services. Pages 177-194 in G.C. Daily, editor. Nature's service: societal dependence on natural ecosystems. Island Press. Washington, D.C., U.S.A.

Peterson, D.L., D.G. Silsbee, and D.L. Schmoldt. 1995. A planning approach for developing inventory and monitoring programs in national parks. Natural Resources Report NPS/NRUW/NRR-95/16, Natural Resources Publication Office, National Park Service, United State of Interior, Denver, Colorado, U.S.A.

Pigram, J.J., and R.C. Sundell, editors. 1997. National parks and protected areas: selection, delimitation, and management. Centre for Water Policy Research, Armidale, Australia.

Pimentel, D., L. Westra, and R.F. Noss, editors. 2000. Ecological integrity: integrating environment, conservation, and health. Island Press, Washington, D.C., U.S.A.

Pipithvanichtham, P. 1997. Issues and challenges of ecotourism in Thai national parks. Pages 72-81 in J. Bornemeier, M. Victor, and P.B. Durst, editors. Ecotourism for forest conservation and community development. Proceedings of an international seminar, January 28-31, 1997, Bangkok, Thailand, RECOFTC Report 15 and RAP publication 1997/42, Regional Community Forestry Training Center, Kasetsart University, Bangkok, Thailand.

Pitayakajornwute, P. 1984. The national park planning process. A document prepared for a seminar of heads of national parks, July 23-30, 1984. National Park Division, Royal Forest Department, Bangkok, Thailand. (in Thai).

Poffenberger, M., editor. 1990. Keepers of the forest: land management alternative in Southeast Asia. Kumarian Press, West Heartford, Connecticut, U.S.A.

Polasky, S., J.D. Camm, A. R. Solow, B. Csuti, D. White, and R. Ding. 2000. Choosing reserve networks with incomplete species information. Biological Conservation 94: 1-10.

Pomeroy, R.S., J.E. Parks, and L.M. Watson. 2002. How is your MPA doing? a guidebook. Working draft version: 31 December 2002.World Commission on Protected Areas– Marine (WCPA-Marine) of the World Conservation Union, Endangered Sea Programme of the World Wide Fund for Nature, and National Ocean Service (NOS) of the United States National Oceanic and Atmospheric Administration.

Pongroongsup, C., and P. Pitayakajornwute. 1989. National park policy. National Park Division, Royal Forest Department, Bangkok, Thailand. (in Thai).

Poore, D. 1993. The sustainable management of tropical forests: the issues. Pages 47-67 in S. Rietbergen, editor. The Earthscan reader in tropical forestry. Earthscan, Publication Limited, London, United Kingdom.

Poore, D. 2003. Changing landscapes: the development of the International Tropical Timber Organization and its influence on tropical forest management. Earthscan, Publication Limited, London, United Kingdom.

Possingham, H.P., D.B. Lindenmayer, and T.W. Norton. 1993. A framework for the improved management of threatened species based on population viability analysis (PVA). Pacific Conservation Biology 1: 39-45.

Powell, G.V.N., J. Barborak, and M. Rodriguez. 2000. Assessing representative of protected natural areas in Costa Rica for conserving biodiversity. Biological Conservation 93: 35-41.

Pradistapongs, P. 1961. The application of forest photogrammetry to forest problem in Thailand. A technical report submitted to Oregon State University in partial fulfillment of the requirements for the degree of Master of Forestry. Oregon State University, Corvallis, Oregon, U.S.A.

Prayurasiddhi, T. 1997. The ecological separation of gaur (*Bos gaurus*) and banteng (*Bos javanicus*) in Huai Kha Khaeng Wildlife Sanctuary, Thailand. Unpublished Ph.D. dissertation, University of Minnesota, U.S.A.

Prayurasiddhi, T., S. Chaiwatana, and S. Napom. 1999. Forest complexes in Thailand. Forestry Biological Diversity Secretary Office, Natural Resources Conservation Office, Royal Forest Department, Bangkok, Thailand. (in Thai with English abstract).

Pressey, R.L. 1994. *Ad hoc* reservation: forward or backward steps in developing representative reserve systems? Conservation Biology 8: 662-668.

Pressey, R.L. 1997. Priority conservation areas: toward an operational definition for regional assessments. Pages 337-357 in J.J. Pigram and R.C. Sundell, editors. National parks and protected areas: selection, delimitation, and management. Centre for Water Policy Research, Armidale, Australia.

Pressey, R.L. 1999. Applications of irreplaceability analysis to planning and management. Parks 9: 42-51.

Pressey, R.L, and S.L. Tully. 1994. The cost of *ad hoc* reservation: a case study in western New South Wales. Australian Journal of Ecology 19: 375-384.

Pressey, R.L., and K.H. Taffs. 2001a. Scheduling conservation action in production landscapes: priority areas in western New South Wales defined by irreplaceability and vulnerability to vegetation loss. Biological Conservation 100: 355-376.

Pressey, R.L., and K.H. Taffs. 2001b. Sampling of land types by protected areas: three measures of effectiveness applied to western New South Wales. Biological Conservation 101: 105-117.

Pressey, R.L., C.J. Humphires, C.R. Margules, R.I. Vane-Wright, and P.H. Williams. 1993. Beyond opportunism: key principles for systematic reserve selection. Trends in Ecology and Evolution 8: 124-128.

Pressey, R.L., I.R. Johnson, and P.D. Wilson. 1994. Shades of irreplaceability: toward a measure of the contribution of sites to a reservation goal. Biodiversity and Conservation 3: 242-262.

Pressey, R.L., S. Ferrier, T.C. Hager, C.A. Woods. S.L. Tully, and K.M. Weinman. 1996. How well protected are the forests of north-eastern New South Wales? – analyses of forest environments in relation to formal protection measures, land tenure, and vulnerability to clearing. Forest Ecology and Management 85: 311-333.

Pressey, R.L., H.P. Possingham, and J.R. Day. 1997. Effectiveness of alternative heuristic algorithms for identifying indicative minimum requirements for conservation reserve. Biological Conservation 80: 207-219.

Pressey, R.L., G.L. Whish, T.W. Barrett, and M.E. Watts. 2002. Effectiveness of protected areas in north-eastern New South Wales: recent trends in six measures. Biological Conservation 106: 57-69.

Pretty, J.N., I. Guijt, I. Scoones, and J. Thompson. 1995. A trainer's guide for participatory learning and action. International Institute for Environment and Development, London, United Kingdom.

Primack, R.B. 1993. Essential of Conservation Biology. Sinauer Asssociates Inc. Sunderland, Massachusetts, U.S.A.

Primack, R.B., and T.E. Lovejoy, editors. 1995. Ecology, conservation, and management of Southeast Asian rainforests. Yale University Press, New Haven, U.S.A.

Prins, H.H.T., and J. Wind. 1993. Research for nature conservation in South-East Asia. Biological Conservation 63: 43-46.

Pulliam, H.R. 1988. Sources, sinks, and population regulation. American Naturalist 135: 652-661.

Pulliam, H.R., and B.R. Johnson. 2002. Ecology's new paradigm: what does it offer designers and planners. Pages 51-84 in B.R. Johnson and K. Hill, editors. Ecology and design: frameworks for learning. Island Press, Washington, D.C., U.S.A.

Rapport, D.J. 1989. What constitute ecosystem health? Perspectives in Biology and Medicine 33: 120-132.

Rapport, D.J. 1995. Ecosystem health: an emerge integrative science. Pages 5-31 in D.J. Rapport, C.L. Gaudet, and P. Calow, editors. Evaluating and monitoring the health of large-scale ecosystems. NATO ASI Series Volume 128. Springer Verlag, Berlin, Germany.

Rapport, D.J., R. Costanza, and A.J. McMichael. 1998a. Assessing ecosystem health. Trends in Ecology and Evolution 13: 397-402.

Rapport, D.J., R. Costanza, P.R. Epstein, C. Gaudet, and R. Levin, editors. 1998b. Ecosystem health. Blackwell Science, Massachusetts, U.S.A.

Rapport, D.J., W.L. Lasley, D.E. Rolston, N.O. Nielsen, C.O. Qualset, and A.B. Damania, editors. 2003. Managing for healthy ecosystems. Lewis Press, Florida, U.S.A.

Raven, P.H, editor. 2000. Nature and human society: the quest for a sustainable world. Proceedings of the 1997 Forum on Biodiversity. Board on Biology, National Research Council. National Academy Press, Washington, D.C., U.S.A.

Reid, W.V. 1998. Biodiversity hotspots. Trends in Ecology and Evolution 13: 275-280.

Repetto, R. 1988. The forest for the trees: government policies and the misuse of forest resources. World Resources Institute, Washington, D.C., U.S.A.

Repetto, R. 1990. Deforestation in the Tropics. Scientific American 262: 36- 42.

Reyers, B., A.S. van Jaarsveld, and M. Kruger. 2000. Complementarity as a biodiversity indicator strategy. Proceedings of the Royal Society of London Biological Science 267: 505-513.

Reyers, B., D.H.K. Fairbanks, K.J. Wessels, and A.S. van Jaarsveld. 2001. Priority areas for the conservation of South African vegetation: a coarse-filter approach. Diversity and Conservation 7: 79-95.

Reyers, B., D.H.K. Fairbanks, K.J. Wessels, and A.S. van Jaarsveld. 2002. A multicriteria approach to reserve selection: addressing long-term biodiversity maintenance. Biodiversity and Conservation 11: 769-793.

RFD. 1985. Thailand national forest policy. Royal Forest Department, Bangkok, Thailand. Also available from http://www.forest.go.th/rfd/policy/ policy_e.htm (accessed 27 September 2000).

RFD. 1989. National park prioritization. Planning sub-division, National Park Division, Royal Forest Department. Unpublished document (in Thai).

RFD. 1990. Master plan formulation for national parks and wildlife sanctuaries. The office of wildlife sanctuary and national park master plan project. Royal Forest Department. Unpublished document (in Thai).

RFD. 1992. Wild Fauna of Thailand. Wildlife Conservation Division, Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand. Unpublished document.

RFD. 1993a. Thai forestry sector master plan. Volume 4: main report. The Office of the Thai Forestry Sector Master Plan (TFSMP), Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

RFD. 1993b. Thai forestry sector master plan. Volume 5: subsectoral plan for people and forestry environment. The Office of the Thai Forestry Sector Master Plan (TFSMP), Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

RFD. 1993c. Thai forestry sector master plan. Volume 6: subsectoral plan for production and utilization. The Office of the Thai Forestry Sector Master Plan (TFSMP), Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

RFD. 1993d. Thai forestry sector master plan. Volume 7: subsectoral plan for institutional development. The Office of the Thai Forestry Sector Master Plan (TFSMP), Royal Forest Department, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

RFD. 1994. Royal Forest Department 98 Years. Report on the 98 years of the RFD establishment. Information Office, Royal Forest Department, Bangkok, Thailand. (in Thai).

RFD. 1996a. Annual report 1995. Information Office, Royal Forest Department, Bangkok, Thailand. (in Thai).

RFD. 1996b. Royal Forest Department 100 Years. Report on the anniversary of the RFD establishment. Information Office, Royal Forest Department, Bangkok, Thailand. (in Thai).

RFD. 1998a. Valuation of natural resources in protected areas: a case study of Khao Yai National Park. Final report. Forestry Research Center, Faculty of Forestry, Kasetsart University and Forest Management and Economic Research Division, Forest Research Office, Royal Forest Department. (in Thai with English abstract).

RFD. 1998b. Valuation of natural resources in protected areas: a case study of Huai Kha Khaeng Wildlife Sanctuary. Final report. Applied Economics Research

Center, Faculty of Economics, Kasetsart University and Forest Management and Economic Research Division, Forest Research Office, Royal Forest Department. (in Thai with English abstract).

RFD. 1999a. Forestry statistics of Thailand 1998. Data Center, Information Office. Bangkok, Thailand. (in Thai and English).

RFD. 1999b. Valuation of natural resources in protected areas: a case study of Erawan National Park, Changwat Kanchanaburi. Final Report. Forestry Research Center, Faculty of Forestry, Kasetsart University and Forest Management and Economic Research Division, Forest Research Office, Royal Forest Department. (in Thai with English abstract).

RFD. 2000. Forestry statistics of Thailand 1999. Data Center, Information Office, Royal Forest Department, Bangkok, Thailand. (in Thai and English).

RFD. 2001a. Master plans: national park and wildlife sanctuary. National Park and Wildlife Research Division, Natural Resource Conservation Office, RFD. Unpublished Documents (in Thai).

RFD. 2001b. Annual Report 2000. Information Office, Royal Forest Department, Bangkok, Thailand. (in Thai).

RFD`. 2001c. Report by the Director General to the Minister of Ministry of Natural Resources and Environment. March 9, 2001. Royal Forest Department, Bangkok, Thailand. Unpublished document (in Thai).

RFD. 2002. Forestry Statistics of Thailand 2001. Data Center, Information Office, Royal Forest Department, Bangkok, Thailand. (in Thai and English). Also available from http://www.forest.go.th/stat41/index.htm (accessed 30 May 2003).

Richardson, K.S., and V.A. Funk. 1999. An approach to designing a systematic protected area system in Guyana. Parks 9: 7-16.

Roberts, C.M. 1998. Sources, sinks, and the design of marine reserve networks. Fisheries 23: 16-19.

Roberts, C.M., and J.P. Hawkins. 2000. Fully-protect marine reserve: a guide. WWF Endangered Seas Campaign, Washington, D.C., U.S.A. and Environment Department, University of York, York, United Kingdom.

Roberts, C.M., S. Andelman, G. Branch, R.H. Bustamante, J.C. Castilla, J. Dugan, B.S. Halpern, K.D. Lafferty, H. Leslie, J. Lubchenco, D. McArdle, H.P. Possingham, M. Ruckelshaus, and R.R. Warner. 2003a. Ecological criteria for evaluating candidate sites for marine reserves. Ecological Applications 13: S199-S215.

Roberts, C.M., G. Branch, R.H. Bustamante, J.C. Castilla, J. Dugan, B.S. Halpern, K.D. Lafferty, H. Leslie, J. Lubchenco, D. McArdle, M. Ruckelshaus, and R.R. Warner. 2003b. Application of ecological criteria in selecting marine reserve and developing reserve networks. Ecological Applications 13: S215-S228.

Robinson, J.G., and E.L. Bennett, editors. 2000. Hunting for sustainability in tropical forests. Columbia University Press, New York, U.S.A.

Rodenburg, W. 1995. Ecodevelopment and buffer zone management planning. Final report, consultant buffer zone management. Food and Agriculture Organization of the United Nation, Rome and Royal Forest Department, Bangkok, Thailand.

Rodrigues, A.S.L., and K.J. Gaston. 2002. Optimisation in reserve selection procedures – why not? Biological Conservation 107: 123-129.

Rodrigues, A.S.L., R. Tratee, B.D. Wheeler, and K.J. Gaston. 1999. The performance of existing networks of conservation areas in representing biodiversity. Proceedings of the Royal Society of London Biological Science 266: 1453-1460.

Roper, J., and R.W. Roberts. 1999. Deforestation: tropical forests in decline. Forestry Issues. CIDA Forestry Advisors Network (CFAN), Canadian International Development Agency (CIDA), Quebec, Canada. Also available from http://www.rcfa-cfan.org/english/issues.12-10.html (accessed 24 October 2002).

Ruhle, G.C. 1964a. A national park system for Thailand 1959-1960. Special publication no. 17. American Committee for International Wildlife Protection, Bronx, New York, U.S.A.

Ruhle, G.C. 1964b. Advisory report on a national park system for Thailand 1959-1960. American Committee for International Wildlife Protection, Bronx. New York, U.S.A.

Sabhasri, S. 1987. The role of forest resources management for development in Thailand. The forestry for development lecture series, University of California, Berkeley, California, U.S.A.

Sandwith, T., C. Shine, L. Hamilton, and D. Sheppard. 2001. Transboundary protected areas for peace and cooperation. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

Santisuk, T., T. Smitinand, W. Hoamuangkaew, P. Ashton, S.H. Sohmer, and J.R. Vincent. 1991. Plant for our future: botanical research and conservation needs in Thailand. Royal Forest Department, U.S. Agency for International Development, and World Wildlife Fund U.S., The Chutima Press, Bangkok, Thailand.

Sarakinos, H., A.O. Nicholls, A. Tubert, A. Aggarwal, C.R. Margules, and S. Sarkar. 2001. Area prioritization for biodiversity conservation in Quebec on the basis of specie distribution: a preliminary analysis. Biodiversity and Conservation 10: 1419-1472.

Sato, J. 2002. Karen and the land in between. Pages 277-295 in D. Chatty and M. Colchester, editors. Conservation and mobile indigenous people: displacement, forced settlement and sustainable development. Berghahn Books, United Kingdom.

Saunders, D.A., R.J. Hobbs, and P.R. Ehrlich. 1993a. Nature Conservation 3: Reconstruction of Fragmented Ecosystems. Surrey Beatty and Sons Pty Limited, New South Wales, Australia.

Saunders, D.A., R.J. Hobbs, and P.R. Ehrlich. 1993b. Repairing a damaged world; an outline for ecological restoration. Surrey Beatty and Sons Pty Limited, New South Wales, Australia.

Schaeffer, D.J., E.E. Herrricks, and H.W. Kerster. 1988. Ecosystem health: I. measuring ecosystem health. Environmental Management 12: 445-455.

Schwartz, M.W. 1999. Choosing the appropriate scale of reserves for conservation. Annual Review of Ecology and Systematics 30: 83-108.

Scott, J. M., B. Csuti, and S. Caicco. 1991a. Gap Analysis: assessing protection needs. Pages 15-26 in W. E. Hudson, editor. Landscape linkages and biodiversity, Island Press, Washington, D.C., U.S.A.

Scott, J. M., B. Csuti, and F. Davis. 1991b. Gap analysis: an application of geographic information systems for wildlife species. Pages 167-180 in D. J. Decker, M. E. Krasny, G. R. Goff, C. R. Smith, D. W. Gross, editors. Challenges in the conservation of biological resources: a practitioner's guide. Westview Press, Boulder, Colorado, U.S.A.

Scott, J. M., B. Csuti, K. Smith, J. E. Estes, and S. Caicco. 1991c. Gap analysis of species richness and vegetation cover: an integrated biodiversity conservation strategy. Pages 282-297 in K. A. Kohm, eitors. Balancing on the brink of extinction: the Endangered Species Act and lessons for the future. Island Press. Washington, D. C., U.S.A.

Scott, J. M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T. C. Edwards Jr., J. Ulliman, and G. Wright. 1993. Gap Analysis: a geographic approach to protection of biodiversity. Wildlife Monographs 123: 1-41.

Scott, J.M., T.H. Tear, and F.W. Davis, editors. 1996. Gap analysis: a landscape approach to biodiversity planning. American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, U.S.A.

Scott, J.M., M. Murray, R.G., Wright, B. Csuti, P. Morgan, and R.L. Pressey. 2001a. Representation of natural vegetation in protected areas: capturing the geographic range. Biodiversity and Conservation 10: 1297-1301.

Scott, J.M., F.W. Davis, R.G. McGhie, R.G., Wright, C. Groves, and J. Estes. 2001b. Nature reserve: do they capture the full range of America's biological diversity? Ecological Application 11: 999-1007.

Sellars, R.W. 1997. Preserving nature in the national parks: a history. Yale University Press, New Haven, U.S.A.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. BioScience 131-134.

Sheppard, D. 1998. The road from Caracas. Paper presented at the IUCN World Commission on Protected Areas Symposium on Protected Areas in the 21st Century: from islands to networks, 24-29 November 1997, Albany, Australia.

Shindler, B., and A. Wright. 2000. Watershed management in the central cascades: a study of citizen knowledge and the value of information sources in the lower south Santiam Basin. Department of Forest Resources, Oregon State University, Corvallis, Oregon, U.S.A.

Simberloff, D. 1998. Flagships, umbrellas, and keystones: is single-species management passé in the landscape era? Biological Conservation 83: 247-257.

Simberloff, D. 1999. The role of science in the preservation of forest biodiversity. Forest Ecology and Management 115: 101-111.

Singh, S. 1999. Assessing management effectiveness of wildlife protected areas in India. Parks 9: 34-49.

Silsbee, D.G., and D.L. Peterson. 1991. Designing and implementing comprehensive long-term inventory and monitoring programs for national park system lands. Natural Resources Report NPS/NRUW/NRR-91/04, National Park Service, United States Department of the Interior, U.S.A.

Smith, P.G.R., and J.B. Theberge. 1986. A review of criteria for evaluating natural areas. Environmental Management 10: 715-734.

Sobel, J. 1996. Marine reserve: necessary tools for biodiversity. Global Biodiversity 6: 8-18.

Sodhi, N.S., and L.H. Liow. 1999. Improving conservation biology research in Southeast Asia. Conservation Biology 14: 1211-1212.

Soulé, M.E. 1985. What is conservation biology? BioScience 35: 727-734.

Soulé, M.E., and R.F. Noss. 1998. Rewilding and biodiversity: complementary goals for continental conservation. Wild Earth 8: 18-28.

Soulé, M.E., and J. Terborgh, editors. 1999. Continental conservation: scientific foundations of regional reserve networks. Island Press, Washington, D.C., U.S.A.

Spellerberg, I.F., and J.W.D. Sawyer. 1999. An introduction to applied biogeography. Cambridge University Press, Cambridge, United Kingdom.

Spies, T.A. 1997. Forest stand structure, composition, and function. Pages 11-30 in K.A. Kohm, and J.F. Franklin, editors. Creating a forestry for the 21st century: the science of ecosystem management. Island Press, Washington, D.C., U.S.A.

Spies, T.A. 1998. Forest structure: a key to the ecosystem. Northwest Science 72: 34- 39.

Spies, T.A., and M.G. Turner. 1999, Dynamic forest mosaics. Pages 95- 160 in M.L. Hunter, editor. Maintaining biodiversity in forest ecosystems. Cambridge University Press, Cambridge, Massachusetts, U.S.A.

Sretarugsa, A. 2000. Alternatives for socio-economic development in national parks. Army War College, Institute of Army Academy, Ministry of Defense, Bangkok, Thailand. Unpublished document (in Thai).

Srikosamatara, S. 2000. Monitoring densities and distributions of larges mammals: Huai Kha Khaeng Wildlife Sanctuary, Thailand. Pages 390-395 in A. Galt, T. Sigaty, and M. Vinton, editors. World Commission on Protected Areas, 2nd Southeast Asia Regional Forum, Pakse, Lao PDR, 6-11 December 1999. Volume II – Papers Presented. IUCN, Vientiane, Lao PDR.

Stankey, G.H. 2002. Senior Researcher, USDA Forest Service, Pacific Northwest Research Station, Corvallis, Oregon. (Personnal communication).

Stankey, G.H., D.N. Cole, R.C. Lucas, M.E. Peterson, and S.S. Frissell. 1985. The Limits of Acceptable Change (LAC) system of wilderness planning. USDA Forest Service, Intermountain Forest and Range Experimental Station, General Technical Report: INT-GTR- 176, Ogden, Utah, U.S.A.

Stern, M., S. Bhagwat, N. Brown, T. Evans, S. Jennings, and P. Savill. 2001. Park and factors in their success. Science 293: 1045-1047.

Stolton, S., and N. Dudley, editors. 1999. Partnerships for protection: new strategies for planning and management for protected areas. Earthscan Publications, Limited, London, United Kingdom.

Suntajit, K. 2001. Survey of key species in wildlife sanctuaries in Thailand. National Park and Wildlife Research Division, Natural Resources Conservation Office, Royal Forest Department. (Personal communication).

Suprichakorn, T. 1959. Forestry in Thailand. A technical report submitted to Oregon State College in partial fulfillment of the requirements for the degree of Master of Forestry. Oregon State University, Corvallis, Oregon, U.S.A.

Swanson, F.J., and R.E. Sparks. 1990. Long term ecological research and the invisible place. BioScience 40: 502-508.

Swanson, F.J., and R. Molina. 2000. Ecological processes and functions. Pages 62-123 in R.W. Haynes, and G.E. Perez, editors. Northwest Forest Plan research synthesis. USDA Forest Service, Pacific Northwest Research Station, PNW-GTR-498, Portland, Oregon, U.S.A.

Swanson, F.J., J.A. Jones, D.O. Wallin, and J.H. Cissel. 1993. Natural variability – implication for ecosystem management. Pages 89-103 in M.E. Jensen and P.S. Bourgeron, editors. Eastside forest ecosystem health assessment, Volume II. Ecosystem management: principle and applications. USDA Forest Service, PNW- GTR-318, Pacific Northwest Research Station, Portland, Oregon, U.S.A.

Swanson, F.J, J.A. Jones, and G. E. Grant. 1997. The physical environment as a basis for managing ecosystem. Pages 229-238 in K.A. Kohm, and J.F. Franklin, editors. Creating a forestry for the 21st century: the science of ecosystem management. Island Press, Washington, D.C., U.S.A.

Swanson, F.J., T.K. Kratz, N. Caine, and R.G. Woodmansee. 1988. Landform effects on ecosystem pattern and processes. BioScience 38: 92-98.

Tanakanjana, N. 1996. Analysis of nonconforming behaviors of local people in the national park system of Thailand. Unpublished Ph.D. dissertation, Colorado State University, Colorado, U.S.A.

Tanakanjana, N., and G.E. Haas. 1997. Predictive model of nonconforming behaviors of local people in the national park system of Thailand. Pages 32-47 in S. Chettamart, D. Emphandhu, and L. Puangchit, editors. Tropical forestry in the 21 century, volume 5: parks and protected areas. Proceedings of the FORTROP'96 International Conference, 25-28 November 1996, Kasetsart University, Bangkok, Thailand.

Taylor, S.G. 1990. Naturalness: the concept and its application to Australian ecosystems. The Proceedings of the Ecological Society of Australia 16: 411-418.

Terborgh, J., C.V. Schaik, L. Davenport, and M. Rao, editors. 2002. Making parks work: strategies for preserving tropical nature. Island Press, Washington, D.C., U.S.A.

Thorsell, J.W. 1984. A management planning strategy for Khao Yai National Park, Thailand. Tigerpaper 11: 19-26.

Thorsell, J.W. 1985. Threatened protected areas of the Indomalayan realm. Pages 43-49 in J.W. Thorsell, editor. Conserving Asia's natural heritage: The planning and management of protected areas in the Indomalayan realm. Proceedings of the 25th Working Session of IUCN's Commission on National Parks and Protected Areas, 4-8 February 1985, Corbett National Park, India and Cambridge University Press, United Kingdom.

Tilman, D. 1997. Biodiversity and ecosystem functioning. Pages 93-112 in G.C. Daily, editor. Nature's service: societal dependence on natural ecosystems. Island Press. Washington, D.C., U.S.A.

Trisurat, Y. 1992. Application of GIS in protected areas management. Pages 215-225 in H.G. Lund, R. Paivinen, and S. Thammincha, editors. Remote sensing and permanent plot techniques for world forest monitoring. Proceedings of the IUFRO S4.02.05, Wacharakitti International Workshop, 13-17 January 1992, Pattaya, Thailand.

Trisurat, Y. 2003. Defusing the transboundary minefield. ITTO Forest Tropical Update 13: 10-12.

Tungittiplakorn, W., and B. Bengtsson. 1996. A conflict over natural resources between highland and lowland population in Thailand. Pages 513-522 in D.S. Edwards, W.E. Booth, and S.C. Choy, editors. Tropical rainforest research- current issues. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Turner, M.G., S.L. Collins, A.E. Lugo, J.J. Magnuson, T.S. Rupp, and F.J. Swanson. 2003. Disturbance dynamics and ecological response: the contribution of long-term ecological research. BioScience 53: 46-56.

Turpie, J.K., L.E. Beckley, S.M. Katua. 2000. Biogeography and the selection of priority areas for conservation of South African coastal fishes. Biological Conservation 92: 59-72.

Ulanowicz, R.E. 2000. Toward the measurement of ecological integrity. Pages 99-113 in D. Pimentel, L. Westra, and R.F. Noss, editors. Ecological integrity: integrating environment, conservation, and health. Island Press, Washington, D.C., U.S.A.

UNESCO. 2002. Biosphere reserves: special places for people and nature. UNESCO, Paris. France.

Urbanska, K.M., N.R. Webb, and P.J. Edwards. 1997. Cambridge University Press, Cambridge, United Kingdom.

Usher, M.B., and C. Margules. 1981. Criteria used in assessing wildlife conservation potential: a review. Biological Conservation 21: 79-109.

Vandergeest, P. 1996a. Mapping nature: territorialization of forest rights in Thailand. Society and Natural Resources 9: 159-175.

Vandergeest, P. 1996b. Property rights in protected areas: obstacles to community involvement as a solution in Thailand. Environmental Conservation 23: 259-268.

Vandergeest, P. 1999. Reply: protected areas and property rights in Thailand. Environmental Conservation 26: 7-9.

Vejaboosakorn, S. 1984. Guideline for national park management. A document prepared for a seminar of heads of national parks, July 23-30, 1984. National Park Division, Royal Forest Department, Bangkok, Thailand. (in Thai).

WCPA. 1998. Economic values of protected areas - guidelines for protected areas managers. Task Force on Economic Benefits of Protected Areas of the World Commission on Protected Areas of IUCN in collaboration with the Economics Service Unit of IUCN. IUCN, Gland, Switzerland and Cambridge, United Kingdom.

WCPA. 2000. Financing protected areas - guidelines for protected area managers. Financing Protected Areas Task Force of World Commission on Protected Areas, IUCN, Gland, Switzerland and Cambridge, United Kingdom.

Wells, M., and K. Brandon. 1992. People and parks: linking protected area management with local communities. The World Bank, Washington, D.C., U.S.A.

Werner, W.L., and T. Santisuk. 1993. Conservation and restoration of montane forest community in Thailand. Pages 193-202 in H. Leith and M. Lohmann, editors. Restoration of tropical forest ecosystems. Proceedings of the symposium held on October 7-10, 1991, University of Osnabruck, Germany. Kluwer Academic Publisher, Dordrecht, The Netherlands.

Westra, L. 1995. Ecosystem integrity and sustainability: the foundation value of the wild. Pages 12-33 in L. Westra and J. Lemons, editors. Perspectives on ecological integrity. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Wikramanayake, E.D, E. Dinerstein, C.J. Loucks, D.M. Olson, J. Morrison, J. Lamoreux, M. Mcknight, and P. Hedao. 2002. Terrestrial ecoregions of the Indo-Pacific: a conservation assessment. World Wildlife Fund and Island Press, Washington, D.C., U.S.A.

Williams, P., D. Gibbons, C. Margules, A. Rebelo, C. Humphries, and R. Pressey. 1996. A comparison of richness hotspots, rarity hotspots, and complementary areas for conserving diversity of British birds. Conservation Biology 10: 155-174.

Williams, P.H. 1998. Key sites for conservation: area-selection methods for biodiversity. Pages 211-249 in G.M. Mace, A. Balmford, and J.R. Ginsberg, editors. Conservation in a changing world. Cambridge University Press, Cambridge, United Kingdom.

Wiryanti, W. 2000. Asean agreement on nature and natural resources ASEAN declaration on heritage parks and reserves. Pages 46-51 in Proceedings on the workshop on guidelines and criteria for the selection and establishment of ASEAN heritage parks, 20-22 September 2000, Hanoi, Vietnam. The ASEAN Regional Centre for Biodiversity Conservation (ARCBC), University of the Philippines, Los Banos Laguna, Philippines.

With, K.A. 1997. The theory of conservation biology. Conservation Biology 11: 1436-1440.

Wondolleck, J.M. 1988. Public lands conflict and resolution: managing national forest disputes. Plenum Press, New York, U.S.A.

Wondolleck, J.M., and S.L. Yaffee. 2000. Making collaboration work: lessons from innovation in natural resource management. Island Press, Washington, D.C., U.S.A.

Wongwathana, P. 1995. Accomplishment of national park establishment in forest protection and some factors affecting changes of forest area: a case study of northern Thailand. Unpublished Master Thesis, Kasetsart University, Bangkok, Thailand.

Wood, H., M. McDaniel, and K. Warner, editors. 1995. Community development and conservation of forest biodiversity through community forestry. Proceedings of an international seminar, held in Bangkok, Thailand, October 26-28, 1994. RECOFTC Report 12. Regional Community Forestry Training Center, Kasetsart University, Bangkok, Thailand.

Worboys, G., M. Lockwood, and T. De Lacy. 2001. Protected area management: principle and practice. Oxford University Press, New York, U.S.A.

WWF. 2000. Beyond the trees. An International Conference on the Design and Management of Forest Protected Areas. 8-11 May 2000, Bangkok, Thailand. WWF Forest for Life Campaign, the Royal Government of Thailand, and IUCN's World Commission on Protected Areas. Bangkok, Thailand.

WWF. 2001. WWF Rapid assessment and prioritization methodology for protected area system. WWF Forest for Life Programme, WWF International, Gland, Switzerland.

Wright, R.G., editor.1996. National parks and protected areas: their role in environmental protection. Blackwell Science, Cambridge, Massachusetts, U.S.A.

Yaffee, S.L., and J.M. Wondolleck. 1997. Building bridges across agency boundaries. Page 381-396 in K.A. Kohm and J. F. Franklin, editors. Creating a forestry for the 21st century: the science of ecosystem management. Island Press, Washington, D.C., U.S.A.

Yazvenko, S., and D.J. Rapport. 1996. A framework for assessing forest ecosystem health. Ecosystem Health 2: 40-51.

Zacharias, M.A., and J.C. Roff. 2001. Use of focal species in marine conservation and management: a review and critique. Aquatic Conservation: Marine and Freshwater Ecosystems 11: 59-76.

Appendices

Appendix 1. Conservation biology concepts.

Concept	Objective	Assumption	Benefit	Limitation	References
Island biogeography	The number of species on islands depends on the habitat (size) of islands and on the balance between extinction and immigration.	Based on the assumption that island size and level of isolation regulate extinction and immigration rates, which would make the extinction rate less likely on a lager island and immigration more likely to occur on the less isolated islands (or those closer to the mainland).	Theoretically, the concept can be used when designing reserves; e.g., large reserves to avoid extinction and support more species, and closer reserve networks to facilitate the movement of individual species.	The concept may not work when an island is surrounded by agricultural lands, which cause pressures from high threats and uncertainty.	MacArthur and Wilson (1967), Diamond (1975), Diamond and May (1981).
Metapopulation	Subpopulations distribute throughout habitat islands. Subpopulations	Based on an assumption that, over time, subpopulations will exist both in	At the local scale subpopulations could be sources and sinks and could be	Interactions caused by moving among individual patches through a	Hanski (1991), Harrison (1991), Hasting and Harrison (1994), Hanski (1999a,

Appendix 1. (Continued).

	have a dynamic of colonization and extinction.	today's areas of colonization and in current areas of extinction. Suitable habitats may not be occupied but some of them may be occupied, therefore meta-population as a whole still persists.	colonized if habitats are well protected, the connectivity is created, or the number of patches is increased with a corresponding increased in capacity. This should be the concern when building networks.	matrix of unsuitable habitats are a substantial risk, and difficult to manage at the geographical scale. Much data is required (i.e., dispersal demography) to implement this concept.	1999b).
Source- sink populations	Source habitats could emigrate individuals that are surplus due to reproductive success which exceed local mortality. Sink habitats receive immigration from	Populations could be both sink and source, or switch between the two, as well as be stepping stones for other habitats.	Both source and sink play major roles in supporting, protecting, and reuniting populations.	In some cases, it's hard to define source or sink, or either of them may exist outside protected areas, within other types of land ownerships (e.g., private lands).	Pulliam (1988), Dias (1996), Pulliam and Johnson (2002).

Appendix 1. (Continued).

	source habitats, due to reproductive deficits when mortality is greater than the reproduction rate.			This concept needs a lot of data (e.g., identification of sources and sink habitats, demography, dispersal) to be implemented.	
Coarse & fine filters (1) Coarse filter	The approach uses a large scale (e.g., multiple species) in reserve design & management.	By approaching at a larger scale, we may capture all targeted species, habitats, or representations.	The concept takes all possible target species and habitats into account. This large scale approach include patterns and processes of ecosystem (e.g., at landscape scale, ecoregion)	Capturing representations of ecosystems requires good and updated data and sufficient resources, as well as technology.	Hunter (1988), Hunter et al. (1988), Hunter (1996, 1999), Haufler (1999), Schwartz (1999).

Appendix 1. (Continued).

(2) Fine filter	The approach use a small scale (e.g., single species) in reserve design & management.	To approach by at smaller scale is feasible because it uses less resources and data is already available in some areas.	It is beneficial for the area that has information about target species, and in the situation that needs, a quick solution (e.g., indicators species).	The approach may not capture significant targeted species or habitats, as well as patterns and processes. Using fine filter (e.g., single species) may introduce bias and ignore other species that are not included.	Hunter (1988), Hunter et al. (1988), Hunter (1996, 1999), Haufler (1999), Schwartz (1999).
Ecosystem health	The system to which it is applied is stable and sustainable, maintains its organization and autonomy overtime, and has resilience to stress.	Assumes that indicators of ecosystem health are rigorous (measured by activities, metabolisms or productivities): Organization (diversity and	A healthy ecosystem can be used as a major goal in protected area management.	Different people define ecosystem health in different ways. Sometimes the concept is considered as human health. It is still difficult to measure ecosystem health	Haskell et al. (1992), Karr (1995), Rapport (1995), Rapport et al. (1998a, 1998b), Edmonds et al. (2000), Rapport et al. (2003).

Appendix 1. (Continued).

		numbers of interactions between systems), and resilience (capacity to maintain structures and functions under threats).		by using 3 indicators under the assumptions.	See methods to estimate forest health in Innes (1993) and ecosystem health in Schaeffer et al. (1988), Cairns et al. (1993), Yazvenko and Rapport (1996).
Ecosystem service	The services generated by a complex natural cycle that sustains and supports life functions.	Assume that conditions and processes of sustaining natural ecosystems would provide ecosystem functions to organisms, including humans.	Ecosystem services should be considered as long-term benefits for protecting biodiversity.	People benefit directly from ecosystem services but view ecosystem service as an abstract idea.	Daily (1997a, 1997b, 1997c): Tilman (1997); Myers (1997).
Ecological integrity	Ecological integrity is the combination of	Based on the assumption that a system that has	This concept could be used as the major goal in	The concept is usually viewed as abstract idea.	Karr (1992), Noss (1995), Westra (1995),

Appendix 1. (Continued).

	physical, chemical, and biological integrity.	integrity can withstand, and recover from, perturbations and disruptions introduced by human or natural causes.	protected area management.	People often confuse it with ecosystem health, which is not the same.	Karr (2000), Pimentel et al. 2000, Noss et al. (1999), Andreasen et al. (2001).
Range of variability	The range and variation of ecological conditions in spatial and temporal scales.	Based on assumptions that past processes and conditions as well as spatial and temporal processes of disturbance provide the context and guidance to ecosystem management.	The concept is increasingly used in ecosystem assessment, design, and management. The concept helps to understand biodiversity and could be applied to maintain biodiversity and restore the ecosystem. It can be used as a benchmark to assess impacts	Limits in interpretation of past ecosystem variability, resulting from impacts of environmental conditions (e.g., climate change) that change the system out of the range of variability. The public is sometimes confused by this concept because	Swanson et al. (1993), Morgan et al. (1994), Landres et al. (1999).

Appendix 1. (Continued).

			from anthropogenic changes.	they perceive it as too abstraction.	
Naturalness	The conditions of natural conditions.	Based on the assumption that natural areas have minimal, or no, disturbance from humans.	The concept is used as a baseline to set up nature reserves, or wilderness areas.	Difficult to find natural areas to design wilderness areas or reserves, or to use as a benchmark for managing an area.	Taylor (1990), Maser (1990).
Representative-ness	The representation of units (e.g., species, habitats, landscapes, or regions) in an area.	Assumes that to fully and effectively preserve natural resources, reserves need to protect all key units in the area such as species, groups of species, regions, ecosystems, and any groups of	Reserves contain all representations that are necessary for patterns and processes in the ecosystems as well as the existence of key species.	In some areas, key representations do not exist. Needs more resources if applied with gap analysis, e.g., needs to have good data and technology (e.g., GIS). The concept	Mondor (1990), Pressey et al. (1997, 2002), Pressey and Taffs (2001b).

Appendix 1. (Continued).

		classifications.		cannot be applied to other regions since the key representations vary on a case by case basis.	
Complementarity	Species, habitats, or landscapes that are considered for inclusion in existing protected area systems.	By including complementary species, habitats, and landscapes, reserves effectively protect and support species existence.	Use this concept in combination with the gap analysis to reviews existing reserve to include any lacking representations.	Need to have available data, or existing reserve systems that can be applied with gap analysis.	Pressey et al. (1993), Williams et al. (1996), Pressey (1997), Williams (1998), Reyers et al. (2002).
Irreplaceability	Individuals or groups of species, habitats, or landscapes that are necessary to patterns and processes of ecosystem. The irreplaceable unit	If individual or groups of species, habitats, or landscapes are left out, patterns or processes of an ecosystem may be interrupted.	Individuals or groups of species, habitats, or landscapes that are included in the reserve system are necessary for the stability of	It is still controversial and difficult to identify, what are the roles of individuals or groups of species, habitats, or landscapes in	Pressey et al. (1993), Pressey et al. (1994), Pressey (1999).

Appendix 1. (Continued).

	cannot be left out from the system.		ecosystem.	ecosystem, especially in areas that lack data. Irreplaceable units may not exist in reserves.	
Focal species/units					- Definition: Miller et al. (1998), Fleishman et al. (2000). - Methods to select focal species/units: Fleishman (2000). - See texts for more details of focal species/units.
(1) Indicator	Species used to indicate sensitive changes in an	Assumes that indicator species would provide	Beneficial when applied to monitoring	Key point is to choose the right indicator, which	Landres et al. (1988), Miller et al. (1998),

Appendix 1. (Continued).

	ecosystem (e.g., environmental/ecological changes) and are useful in monitoring quality of habitats.	early warning for a system and be a surrogate for ecological integrity.	habitat quality. Instead of collecting a lot of data, researchers could save cost when applying the indicator concept to large areas to monitor changing of environment.	depends on the desired goals. Limitations of data and continuation of project would be obstacles to applying indicator species in the monitoring process.	Zacharias and Roff (2001), Hansson (2001).
(2) Keystone	Species play major roles in ecosystem processes and functions through their activities (e.g. predation).	Their removal would have significant effects to changes in structures, compositions, and functions of ecosystems. These changes may interrupt processes in the ecosystem and	Keystone species can be used as the target of management because their pronounced effects on the integrity of ecosystem. In some cases, it makes more sense to invest in	Lack of data and target species are key limitations. If keystones species do not exist, it's difficult to design.	Mills et al. (1993), Miller et al. (1998), Simberloff (1998), Zacharias and Roff (2001).

Appendix 1. (Continued).

		often result in loss of biodiversity	protecting keystone species instead of investing in each individual in the ecosystem.		
(3) Flagship	Flagship species are charismatic species used to campaign for conservation objectives.	Based on the notion that using flagship species would gain support from the public in campaigning for conservation agenda.	Flagship species could be a litmus to test the support in conservation objectives. They are non-biological variables that could be used to draw attention from the public through public relations or education campaigns.	Limitation is the lack of charismatic species in some countries. Perception is another issue. If the flagship species do not exist, the public will lose interests.	Miller et al. (1998), Simberloff (1998), Zacharias and Roff (2001).
(4) Umbrella	Species that cover a large area in their seasonal	Based on the notion that to protect habitat to	Umbrella species is a good candidate to	Need at least demographic data to define their	Lambeck (1997), Miller et al. (1998),

Appendix 1. (Continued).

	and daily movements.	assure a viable population of umbrella species would benefit other species that have more restricted range.	consider as a major target of management. Their protection would help protect other species at the same time. Umbrella species may give some idea of how much land needs to be a reserve.	range. In the area of high vulnerability, using umbrella species may not be enough. Additional approaches (other species) need to be applied.	Simberloff (1998), Zacharias and Roff (2001). Methods to select umbrella species: Fleishman et al. (2000).
Surrogate species/units	Surrogate species or units are used as representations for other species (e.g., species, groups of species, areas, geology, vegetations, environmental factors,	Based on the assumption that using surrogate species/units for the specific goal (e.g., reserve design, reserve selection) would protect other species/units.	If the database is available, using surrogate species or units would save times and resources.	Data limitation. In some case, surrogate species/units do not represent target species.	Caro and O'Doherty (1999), Andelmen and Fagan (2000).

Appendix 1. (Continued).

	functional groups).				
Hotspots					See text for more details of hotspots.
(1) Richness	A number and evenness of species or groups of species in a particular area.	Using species richness in selecting areas for conservation could protect other species.	Richness of species is often used as criteria (e.g., hotspots) in prioritizing reserve for conservation, used in combination with other concepts (e.g., representa-tiveness, complementary, gap analysis) in reserve networks. It also used as surrogate species.	Using richness of species or groups of species (e.g., higher-taxon richness) may not capture other rare or endemic species. Another limitation is the scale used in selecting the area since those richness, rarity, and endemism species may not exist in the same area.	Dinerstein and Wikramanayake (1992), Reid (1998), Caro and O'Doherty (1999).

Appendix 1. (Continued).

(2) Rarity	Species that have a combination of three characteristics: geographical range, habitat, and local population density. Rare species are not wide distributions, do not cover broad habitats, and their local populations are nowhere dense.	Using rare species in conservation prioritization may capture other species.	A rarity hot spot can be used as criteria in reserve design, selection. Rarity can be used with other concepts (e.g., representative-ness) in gap analysis, or with complementary in reserve network. It is also used as surrogate species.	Using the rarity hot spot may not capture other richness or endemic species. It may be expensive if one manages many rarity species instead of using the coarse filter approach. Data are not available in some area.	Reid (1998),
(3) Endemic	Species have a small geographical range and a restricted habitat with local populations that might be small or	Protecting rare species may protect other species as well.	Endemic species could be used to complement phylogeographic studies, which diagnose evolutionarily significant units,	Using an endemic hot spot may not capture richness and rare species. Data is a problem in some areas.	Reid (1998), Myers et al. (2000).

Appendix 1. (Continued).

	somewhere large.		to design conservation area. It can be used as a surrogate species or group of species. The endemic concept can also be used in combination with other concepts (e.g., complementary, representative-ness, gap analysis) in reserve networks.		
(4) Threatened species	Threatened species are species in the critically endangered, endangered, or vulnerable categories under	Threatened species are considered to be facing extremely high risk (critically endangered), a very high risk	Threatened status under the IUCN red list has been widely used as an initial evaluation of species and area status for protection.	Need data to meet criteria designated under the IUCN red data list. The scale becomes an issue since the IUCN may not	IUCN (2001).

Appendix 1. (Continued).

	the IUCN red list data.	(endangered), or high risk (vulnerable) of extinction.		work at the local scale.	
(5) Endangered species	Species are endangered when they have low viable populations, occur in or occupy a small area, and face a very high risk of extinction.	Based on criteria that populations reduce 70% or more over the last 10 years or three generations (whichever is longer), or have fewer than 2500 mature individuals. Their populations are less than 5000 and occupy less than 500 Km^2.	Endangered status is used as the hot spot in designing reserve, selection, and management.	Need data to evaluate status under IUCN red data list. Must be applied to the right scale.	IUCN (2001).
(6) Vulnerability	Vulnerability refers to unprotected species or areas, which are	The hotspot vulnerability is species or areas which are vulnerable to	The vulnerability concept can be applied with the hotspot and representative-	Need data to be used in identifying vulnerable (unprotected)	Faith and Walker (1996), Abbitt et al. (2000), Wright et al. (2001), IUCN

Appendix 1. (Continued).

	endangered from threats.	future species loss, or face a high risk of extinction.	ness concepts to identify species or units that need to be included in the protection, either under individual or reserve networks.	areas, species, and threats.	(2001).
PVA/MVP	Population viability analysis (PVA) is a process used to assess the likelihood of extinction in a particular situation, and the specific at extinction time. MVP is the result from PVA, which is an estimated minimum number of viable individuals of a	Assumes that species are more likely to go extinct in the certain circumstance and at the particular time.	A product from PVA, or MVP, could be applied to calculate the area required by targeted species, which later could be used as a minimum reserve size.	Most PVA are from the programs or simulations, and MVP is the estimation based on the designed conditions. No simple rule, and no testing is done on the ground.	Shaffer (1981), Gilpin and Soule (1986), Boyce (1992), Possingham et al. (1993), Marcot and Murphy (1996), Beissinger and McCullough (2002), (Brigham and Schwartz (2003).

Appendix 1. (Continued).

	species.				
GAP Analysis	Gap Analysis is a concept for identifying species, vegetation types, or units that are not represented in existing protected area systems.	Gap Analysis is a rapid technique for evaluating unprotected conservation of species, areas, ecosystems, or units.	The analysis can be applied to evaluate the representation and adequacy of reserve networks. It can be used in concert with other concepts (e.g., complementary, irreplaceability) to extend the area of an individual reserve and reserve system.	Need available multi-data layers to be overlain in a GIS.	Scott et al. (1991a, 1991b, 1991c); Scott et al. (1993a, 1993b); Csuti et al. (1995); Scott et al. (1996); Jennings (2000).

Appendix 2. Effectiveness of protected area management in Thailand questionnaire.

EFFECTIVENESS OF PROTECTED AREA MANAGEMENT IN THAILAND

I. GENERAL DESCRIPTION OF PROTECTED AREA

Please answer the following questions by filling in the space provided.

1. Name of protected area: ____________________
2. Geographical location: ____________________
3. Date established: ____________________
4. Area (km^2): ____________________
5. Management category: ____________________
6. IUCN protected area category: ____________________
7. Legal status: ____________________
8. Reasons for the establishment: ____________________

____

Please circle one answer, or fill in the space provided.

9. What was the land use category before the protected area was designed?
   a. Public land (i.e., national forest) b. Private land
   c. Community land d. Other (please specify) __________
10. Who was the first group proposing the designation of this protected area?
   a. Government sector b. Private sector
   c. Community d. Other (please specify) __________
11. What was the major reason this protected area was established?
   a. Protect natural resources b. Recreation/Tourism
   c. Political reasons d. Other (please specify) __________
12. What was the major criterion used to set up this protected area?
   a. Ecological service b. Uniqueness
   c. Threat/vulnerability d. Other (please specify) __________
13. What was the major approach used to set up this protected area?
   a. Ad hoc b. Survey
   c. GIS d. Other (please specify) __________
14. Was the protected area ever expanded? If yes, how many times?
   a. One b. Two c. Three or more d. Never expanded
15. If the protected area was ever decreased in size, how many times?
   a. One b. Two c. Three or more d. Never decreased

16. If the protected area was ever re-categorized, how many times?
a. One b. Two c. Three or more d. Never reclassified

II. THREATS

Please answer the following questions in the space provided.

1. What were the major threats to the area before it was set up as a protected area?

2. What were the major impacts to the protected area from the threats in question 1?

3. What are the major threats to the protected area now?

4. What are the impacts to this protected area from the threats in question 3?

5. How does the protected area respond to the impacts in question 4?

6. How is the manager responding to the impacts in question 4?

7. What approach (es) would you like to suggest to the Royal Forest Department to implement to keep the area from threat?

8. What do you think will be the major threats to the protected area in the future?

Below is a list of threats that could threaten the protected area. In each column, rank them following the scale provided.

A. Threat	1= Yes	2= No			
B. Degree of Impacts	1= Critical	2= High	3= Moderate	4= Low	5= Don't know
C. Scale of Impacts (spatial)	1= Critical (>5 km)	2= High (3-4 km)	3= Moderate (1-2 km)	4= Low (<1 km)	5= Don't know
D. Scale of Impacts (temporal)	1= Critical (>30 days)	2 = Long (15-30 days)	3= Moderate (7-14 days)	4= Low (<7 days)	5= Don't know
E. Resistance	1= Critical	2= High	3= Moderate	4= Low	5= Don't know

F. Resilience	1= Critical	2= High	3= Moderate	4= Low	5= Don't know

Threats	A	B	C	D	E	F
1. Land conversion for agriculture						
2. Land encroachment						
3. Illegal logging						
4. Illegal hunting						
5. Collecting fuel wood/ charcoal making						
6. Extraction of non-timber forest product (e.g., collecting mushroom, fodders, honey)						
7. Disturbance (i.e., Fire)						
8. Grazing/livestock						
9. Invasive/exotic species						
10. Disease						
11. Pesticide						
12. Sewage						
13. Mining						
14. Noise						
15. Heavy metal						
16. Acid rain						
17. Access (i.e., trails, roads)						
18. Governmental development projects (i.e., dams)						
19. Land development projects (i.e., golf courses)						
20. Urbanization (i.e., resort, hotel)						
21. Recreation activities						
22. Population density (radius 10 kms)						
23. Other (please specify)						

III. MANAGEMENT AND SYSTEM EFFECTIVENESS

3.1 SYSTEM EFFECTIVENESS

Using the scale below, please tell us how you would rate the effectiveness of the protected area system. Please write one number in the space provided.

1. Very Effective 2. Effective 3. Neutral 4. Ineffective 5. Very Ineffective
6. I don't know

1. Protected areas function ___
2. Method(s) used to set up the protected areas___
3. Criteria used to set up the protected areas___
4. Reasons used to set up the protected areas___
5. Locations of the protected areas ___
6. Sizes of the protected areas ___
7. Number of protected areas___
8. Percentage of the protected areas compared to unprotected areas __
9. Network(s) of protected areas ___
10. Representativeness of plant species contained in the protected areas ___
11. Representativeness of animal species contained in the protected areas ___
12. Representativeness of geological features contained in the protected areas ___
13. Species richness (number of species) contained in the protected areas ___
14. Number of rare species contained in the protected areas ___
15. Number of threatened species contained in the protected areas __
16. Number of endangered species contained in the protected areas ___
17. Number of endemic species contained in the protected areas__
18. Performance of the protected areas in protecting natural resources from threats ___
19. Performance of the protected areas in recovering after a disturbance ___
20. Protected areas in providing service to society ___
21. Protected areas in providing economic benefits to people in this country ___
22. Protected area system in Thailand at the international level ___

Please choose one answer (Yes or No), or answer the following questions by filling in the space provided.

23. Do you feel that present protected systems effectively protect natural resources? (If no, go to question 25).
    a. Yes b. No. c. I don't know
24. If yes, what major criteria do you use to judge the effectiveness in question 23?

____

____

25. If no, what are the three most important reasons that cause protected systems to be ineffective?____

____

26. What suggestions would you make so that the protected area system becomes more effective? ____

____

27. What are the most important natural resources (plant species, wildlife species) in protected areas?

____

____

28. Do you feel that protected areas are big enough to contain the viability of preserved species?

a. Yes b. No. c. I don't know

29. Do you feel that protected areas should be expanded? (If no, go to question 31)

a. Yes b. No. c. I don't know

30. If yes, what is the major reason to expand? ______________________________

____

31. Do you feel that protected areas should be decreased in size? (If no, go to question 33)

a. Yes b. No. c. I don't know

32. If yes, what is the major reason to decrease the size? ____________________

____

33. Do you feel that protected areas should be re-categorized?
(If no, go to question 36)

a. Yes b. No. c. I don't know

34. If yes, what is the major reason to change the category? __________________

____

35. If yes, what category should the protected area be? ______________________

____

36. Do you feel that this area should be a protected area?
(If yes, go to question 38)

a. Yes b. No. c. I don't know

37. If no, what is the major reason? ______________________________________

____

38. Please list rare plant species found in the protected area you govern.

____

____

39. Please list endemic plant species found in the protected area you govern.

____

____

40. Please list rare animal species found in the protected area you govern.

____

____

41. Please list endemic animal species found in the protected area you govern.

____

____

42. What a major groups of organisms do you feel would be a sound indicator for monitoring projects? ______________________________

____

43. What a major group of organisms do you feel would be a sound indicator for evaluating projects? ______________________________

____

44. Does the protected area you govern contain species under the Wildlife Conservation Acts B.E. 2535 (1992)? If yes, please indicate. ____________

____

____

45. Is the protected area you govern isolated from other protected areas? a. Yes b. No

46. Does the protected area you govern contain:

(1) CITES species?	a. Yes	b. No	c. Don't know
(2) IUCN rare species?	a. Yes	b. No	c. Don't know
(3) IUCN threatened species?	a. Yes	b. No	c. Don't know
(4) IUCN endangered species?	a. Yes	b. No	c. Don't know

47. Does the protected area you govern have:

(1) Buffer zone(s)?	a. Yes	b. No	c. Don't know
(2) Natural corridor(s)?	a. Yes	b. No	c. Don't know
(3) Man-made corridor(s)?	a. Yes	b. No	c. Don't know

3.2 MANAGEMENT EFFECTIVENESS

Using the scale below, please tell us how you would rate the effectiveness of the protected area management. Please write one number in the space provided.

1. Very Effective 2. Effective 3. Neutral 4. Ineffective 5. Very Ineffective
6. I don't know

1. Effectiveness of protected area management. ___
2. Performance of the Royal Forest Department in overseeing protected areas. ___
3. Performance of managers in administering protected areas. ___
4. Performance of the Royal Forest Department in public relation projects. ___
5. Performance of managers in communicating with the public. ___
6. Performance of the Royal Forest Department in supporting education projects. ___
7. Performance of managers working in education projects. ___
8. Performance of the Royal Forest Department in providing the public a mechanism to access the information. ___
9. Performance of the managers in providing the public a mechanism to access the information related to the protected units. ___
10. An opportunity provided by the Royal Forest Department for the public to participate in natural resource management. ___
11. Performance of the Royal Forest Department in allowing the public to access the protected areas. ___
12. Performance of the managers in allowing the public to access the protected areas. ___
13. Performance of the Royal Forest Department in solving conflicts in the protected areas. ___
14. Performance of the managers in solving problems related to protected areas management. __
15. Performance of the staff of the Royal Forest Department in working with other governmental organizations. ___
16. Performance of the staff of the Royal Forest Department in working with international organizations. ___
17. Performance of managers in working with the staff of NGOs. ___
18. Performance of the staff of the Royal Forest Department in working with local people. ___
19. Performance of the staff of the Royal Forest Department in working with the researchers from outside the department. ___
20. The level of success of work managed by the staff of the Royal Forest Department in protecting natural resources. ___
21. The level of success of work managed by the staff of the Royal Forest Department to meet the needs of the people in the society. ___
22. The strength of the regulations set up by the Thai government to protect biodiversity under international agreements (i.e., CITES, Convention Biodiversity). ___

Please answer the following questions in the space provided.

23. What do you think has been the most difficult problem with managing protected areas in the past? ____

____

24. What do you think is the biggest problem with managing protected areas now?

____

____

25. If protected area management is ineffective, what are the causes? ____________

____

26. What do you think are the major consequences from management ineffectiveness? ____

____

27. What management techniques would you like to suggest to improve management effectiveness of protected areas? ____________________________

____

28. What do you think will be the biggest problem in the future? _______________

____

Please choose one answer.

a. Yes b. No c. I don't know

The protected area has:
29. Clear objectives. ___
30. Clear goals. ___
31. Policy. ___
32. Sufficient information databases. ___
33. A preliminary plan. ___
34. A master plan. ___
35. An annual plan. ____
36. Program(s) working with local communities. ___
37. Monitoring project(s). ___
38. Ongoing research project(s). ___
39. Eco-tourism project(s). ___
40. Sufficient finances. ___
41. Sufficient equipment. ___

42. Sufficient staff. ___
43. Sufficient facilities. ___

IV. ISSUES AND PROBLEMS

Using the scale below, please tell us what you think about the issues and problems of protected area management. Please write one answer in the space provided.

1. Strongly agree 2. Agree 3. Undecided 4. Disagree 5. Strongly disagree

1. Protected area management should be decentralized. ___
2. Protected area management should be privatized. ___
3. Protected areas should have concessionaires to utilize areas for eco-tourism projects. ___
4. Protected areas should have concessionaires to harvest non-forest products (e.g., mushrooms, bamboo shoots). ___
5. Protected areas should have concessionaires for logging. ___
6. Protected areas should have concessionaires for hunting. ___
7. Managers should have the authority to allow local people to utilize designated areas in the protected areas for eco-tourism projects. ___
8. Managers should have the authority to allow local people to harvest non-forest products (i.e., mushrooms, bamboo shoots). ___
9. Managers should have the authority to allow local people to log in the protected area. ___
10. Managers should have the authority to allow local people to hunt in the protected area. ___
11. People who are living adjacent to the protected area have a good attitude toward the staff of the protected areas. ___
12. The public has a good attitude toward the protected areas. ___
13. Protected areas have clear boundaries. ____
14. People who are living adjacent to the protected areas understand the boundaries. ___
15. People who are living adjacent to the protected areas accept the boundaries. ___
16. The public should have the right to access information in the Royal Forest Department. ___
17. People who are living adjacent to the protected area understand the regulations of the protected areas. ___
18. People who are living adjacent to the protected area accept the regulations of the protected areas. ___

19. People who are living adjacent to the protected area behave according to the regulations of the protected areas. ___

V. RESEARCH AND EDUCATION

Using the scale below, please tell us what you think about the importance of research and education projects to protected area management.

1. Very important 2. Important 3. Undecided 4. Not important

1. Data for protected area management:
   (1) Biological data. ___
   (2) Physiological data. ___
   (3) Economical data. ___
   (4) Sociological data. ___
   (5) Political data. ___
   (6) Cultural data. ___
2. Long term monitoring projects. ___
3. Protected area training courses for the staff of the protected units. ___
4. Protected area system plan. ___
5. Research projects conducted by the staff of the Royal Forest department. ___
6. Research projects conducted by researchers from outside of the Royal Forest Department ___
7. Cooperative research projects between staff of the Royal Forest Department and researchers from outside of the RFD. ___

Please answer the following questions.

Research Project Conducted by	Yes/ No	No. of Project (s)	Duration	Budget (Baht)	Source(s) of Funding
1. RFD Staff					
2. Researcher from Outside the RFD					
3. Foreign Researcher					
4. NGO's Researcher					

VI. BACKGROUND INFORMATION

Please answer the following questions.

1. How long have you worked in your present position? _____ year (s)
2. Before working in this position, what was your previous position?

____

3. What is your highest level of completed formal education?

____

4. What was your major in question 3? ______________________________

5. What is your area of expertise? __________________________________

6. In what course(s) relevant to protected area management were you trained?

____

Please use the back of this page to give any comments you may have about the issues being addressed in this questionnaire. Additional information is appreciated.

THANK YOU FOR TAKING TIME TO COMPLETE
THIS QUESTIONNAIRE.

Appendix 3. List of interviewees.

Name	Position/Organization	Subject/Information	Remark/Date of Interview
Pongboon Pongtong	Research Forester National Park Division	NP & Tourism Policy NP Administration PA Management	Sept.11, 2001
Preecha Chansiritanon	Forest Inspector	NP Management PA Management	Sept.12, 2001 Former Director of National Park Division
Taweechai Senisrisant	Director of Forest Land Resource Division	National Forest Management, Conflict Resolutions, PA Management	Sept.12, 2001 Former Director of Marine National Park Division
Tawee Nootong	Senior Wildlife Biologist and Chief of Wildlife Research Sub-Division	Wildlife Management PA Management	Sept.14, 2001
Chawalit Niyomdham Ph.D.	Director of Forest Botany Division	PA Management	Sept.14, 2001
Sawat Dulyapach	Director of Forest Forest Protection Office	PA Management	Sept.14, 2001 Former Director of Natural Resources Conservation Office. As of

Appendix 3. (Continued).

			May 2003: Deputy Director Generals of the Park, Wildlife and Plant Conservation Department
Pakon Saranakom	Chief of Non-Hunting Area Sub-Division, Wildlife Conservation Division	Wildlife Sanctuary Management PA Management	Sept.16, 2001 Former Head of Wildlife Sanctuary
Wachira Muangkaew	Director of Tak Regional Forest Office	PA Management	Sept.20, 2001
Chatchawan Pisdamkham	Senior Research Forester and Project Manager of WEFCOM	PA Management and Natural Resource Conservation	Sept.24, 2001 Former Head of Wildlife Sanctuary
Seri Vejaboosakorn	Faculty, Department of Conservation, Faculty of Forestry, Kasetsart University	PA Management NP Management and Planning	Sept.24, 2001 Former Director of Wildlife Conservation Division and Senior Research Forester at National Park Division
Thavorn Lamseejan	Director of Information Office	PA Management	Sept.25, 2001 Former Director of Natural Resource

Appendix 3. (Continued).

			Conservation Office
Suvat Singhapant	Director of Reforestation Office	PA Management	Sept.25, 2001 Former Director of National Park Division and Deputy Director General of the RFD. As of May 2003: Deputy Permanent Secretary of the Ministry of Natural Resources and Environment
Preecha Ratanaporn	Director of Wildlife Conservation Division	PA Management and Wildlife Conservation	Sept.26, 2001
Nopparat Naksathit	Senior Wildlife Biologist and Chief of Wildlife Conservation Extension Sub-Division, Wildlife Conservation Division	PA Management and Wildlife Conservation	Sept.26, 2001 Former Head of Wildlife Research Station
Prayut Lorsuwansiri	Director of Marine National Park Division	PA Management, Conflict Resolutions, and Marine NP Management	Sept.26, 2001 Former Director of Training Division

Appendix 3. (Continued).

Yongyut Trisurat Ph.D.	Faculty, Forest Biology Department	PA Management and NP Management	Sept.27, 2001 Former Research Forester and Park Manager
Theerapat Prayurasiddhi Ph.D.	Conservation Biologist Chief, Ecological Monitoring Section, Western Forest Complex Project, Royal Forest Department	PA Management and Conservation	Sept.27, 2001
Vichit Phattanogosai	Director of National Park Division	PA Management NP Management	Sept.28, 2001
Apinun Ploadpliew	Expert Senior Officer Forest Fire Control & Natural Danger Office	PA Management and Forest Fire Management	Sept.28, 2001 Former Director of Forest Fire Control Division
Apiwat Sretarugsa	RFD Inspector in charge of Office for Strengthening Ecotourism in National Parks	PA Management, Planning, and Ecotourism in National Park.	Oct.10, 2001 Former Director of Planning Division and Director of Natural Resources Conservation Office. As of May 2003: Deputy Director Generals of the Park, Wildlife and

Appendix 3. (Continued).

			Plant Conservation Department
Plodprasop Suraswadi Ph.D.	Director General of Royal Forest Department	PA Management and Policy	Oct.12, 2001. As of May 2003: Permanent Secretary of the Ministry of Natural Resources and Environment

Appendix 4. Data sources.

Name	Position/Organization	Subject/Information	Remark/Date of Contact
Saovakorn Sudsawasd Ph.D.	Department of Sociology, Kasetsart University	Questionnaire Reviews	Jul. 2001
Wuthipol Hoamuangkaew Ph.D.	Professor Department of Forest Management Faculty of Forestry Kasetsart University	Research Approach PA Management	Jul.10&13, 2001
Professor Surachet Chettamart	Associate Dean and Professor, Department of Conservation Faculty of Forestry Kasetsart University	Research Approach Questionnaire Reviews Expert opinion: PA Management and Planning	Jul.-Oct. 2001
Sompetch Mungkorndin Ph.D.	Professor Emeritus Department of Forest Management Faculty of Forestry Kasetsart University	Forestry Terminology Forest Economics and Management, PA Evaluation	Aug.7, 2001
Anak Pattanaviboon Ph.D.	Wildlife Biologist Wildlife Conservation Division and	PA Management Western Complex Data Research Expert Opinion	Jul.-Oct. 2001

Appendix 4. (Continued).

	Western Forest Complex Project, Royal Forest Department	Thesis, Site Visit	
Threerapat Prayurasiddhi Ph.D.	Conservation Biologist Chief, Ecological Monitoring Section. Western Forest Complex Project, Royal Forest Department	PA Management Western Complex Data Research Expert Opinion	Jul.-Oct. 2001
Anirut Thanomwattana	Research Forester Data Center, Information Office, Royal Forest Department	Forestry Information	Jul.-Oct. 2001
Piyathip Eawpanich	Thailand Programme Officer, Asia Regional Office, IUCN, Bangkok, Thailand	PA Management PA Evaluation Project Research Advice	Jul.26, 2001 Sept.13, 2001 Oct.9 & 18, 2001
Thongchai Charuppat	Director of Forest Resources Assessment Division, Forest Research Office	Forest Statistics Mangrove Forest Statistics Cabinet Resolution	Sept.4, 2001

Appendix 4. (Continued).

Tippawan Sethapun	Research Forester Marine National Park Division	Marine National Park	Sept.4, 2001
Niwat Jatikanon	Senior Research Forester National Park & Wildlife Research Division	NP & WS Master Plan PA Management	Jul.-Oct. 2001
Apiwat Sretarugsa	RFD Inspector in charge of Office for Strengthening Ecotourism Expert opinion in National Parks	PA Management, Tourism on National Park, PA Policy	Sept.11, 2001 (As of May 2003: Deputy Director General of the Park, Wildlife and Plant Conservation Department, MNRE)
Pongboon Pongtong	Research Forester National Park Division	NP Documents NP & Tourism Policy NP Administration	Jul.-Oct. 2001
Krishna Brikshavana Aurawan Panyapornvittaya	Secretary of the RFD Research Forester Office of the Secretary, RFD	Cabinet resolutions Document and Conflict Resolution in Protected Area Management in Thailand.	Sept. –Aug, 2001
Trujit Mahavihakanont	Senior Officer	National Economic and	Sept.12, 2001

Appendix 4. (Continued).

	Planning Division	Social Development Plan	
Chantanaphorn Ampholchan	Research Forester National Park Division	NP Master Plan	Jul.-Oct. 2001
Dumri Jitjaichum	Research Forester Planning Sub-Division Forester, National Park Division	NP Information	Jul.-Oct. 2001
Songsak Vitayaudom	Chief of Forest Economics Sub-Division Forest Research Office	PA Evaluation	Jul.-Oct. 2001
Dachanee Emphandhu Ph.D.	Professor Department of Conservation Faculty of Forestry Kasetsart University Bangkok	PA Document, Thesis	Sept.17, 2001
Noppawan Tanakanjana Ph.D.	Professor Department of Conservation Faculty of Forestry Kasetsart University	PA Document, Thesis	Sept.17, 2001

Appendix 4. (Continued).

	Bangkok		
Chumpon Chaichana	Research Forester and Assistant Superintendent Mae Tuen Wildlife Sanctuary, Wildlife Conservation Division	Management of Mae Tuen Wildlife Sanctuary, Site Visit.	Aug - Sept. 2001
Kowit Suntajit	Research Forester National Park & Wildlife Research Division	Wildlife Research Information	Jul.-Oct. 2001
Suthathip Dejchaisri	Research Forester National Park & Wildlife Research Division	NP and WS Master Plans	Jul.-Oct. 2001
Rudchapud Podchong	Research Forester Marine National park	Marine National Park	Sept.25, 2001
Chulawan Rromsuwan	Research Forester Marine National park	Marine National Park	Sept.25, 2001
Parinya Boontawee	Head of Forestland Conflict Resolution Sub-Division.	National Forests Questionnaire Production	Aug.22, 2001 Sept.27, 2001

Appendix 4. (Continued).

Jirajet Urasayanan	Head of Administration Section, Forest Research Office.	Research Information	Sept.27, 2001
Peeranuch Dulkul	Research Forester National Park Division	NP Data and Document Thesis	Jul.-Oct. 2001
Pisit Piyasomboon	Research Forester National Park Division	NP Management	Sept. 27, 2001
Chanchai Ngamcharoen	Research Forester & Chief Community Forestry Extension Sub-Division Community Forestry Division, Reforestation Office, RFD	Community Forestry	Oct.12, 2001
Preecha Ongprasert	Research Forester Community Forestry Division, Reforestation Office, RFD	Community Forestry Buffer Zone Management and Evaluation	Jul.-Oct. 2001
Narongrit Sukprakarn	Research Forester Forest Land Resources Division	PA Management Questionnaire Review and Survey, Site Visit	Jul.-Oct. 2001

Appendix 4. (Continued).

Rossana Sawatdiparb	Research Information Center, National Research Council of Thailand	PA Information and Thesis at National Research Council Library	Jul.-Oct. 2001
Vissanu Domrongsutsiri	Research Forester Forest Land Resources Division	Questionnaire Production and Survey	Jul.-Oct. 2001
Atipong Koaphol	Research Forester Forest Land Resources Division	Questionnaire Production and Survey	Jul.-Oct. 2001
Wassana Kongkhew	Research Forester Forest Land Resources Division	Questionnaire Production and Survey	Jul.-Oct. 2001
Kobsak Wanthongchai	Professor Department of Silviculture Faculty of Forestry, Kasetsart University, Bangkok	PA Management	Jul.-Oct. 2001
Pajon Tanamittramanee	Research Forester and Head of Nam Tok Phrew National Park	PA Management Site Visit	Aug. 2001

Appendix 4. (Continued).

Apisit Pidthong	Research Forester and Assistant Superintendent Khao Soi Dao Wildlife Sanctuary	PA Management Site Visit	Aug.11, 2001
Paitoon Tonpayom	Research Forester and Head of Mae Tuen Wildlife Sanctuary	PA Management Site Visit	Sept. 2001
Krissada Homsud	Research Forester and Head of Lan Sang National Park	PA Management Site Visit	Sept. 2001
Prasong Saguantam	Professor Department of Forest Management, Faculty of Forestry, Kasetsart University, Bangkok	PA Evaluation and Forest Management	Jul.- Aug. 2001
Charat Chuayna	Research Forester RFD	PA Management	Jul.-Oct. 2001
Lert Chuntanaparb Ph.D.	Professor Department of Forest Management, Faculty of Forestry, Kasetsart	PA Management and Policy and Research Advice	Sept.- Oct. 2001

Appendix 4. (Continued).

	University, Bangkok		
Kankhajane Chuchip Ph.D.	Professor Department of Forest Management, Faculty of Forestry, Kasetsart University, Bangkok	PA Management Forest Research	Jul.- Aug. 2001

Appendix 5. Similarities and differences of protected areas between Thailand and the United States of America.

Similarity/Difference	US National Park	Thai National Park	Comment/ Reference
I. Similarities: 1. Organization.	- The Park Service is a federal government under the Ministry of Interior.	- The Park, Wildlife, and Plant Conservation Department is under the Ministry of Natural Resources and Environment (PWPCD 2003, MONRE 2003).	- Before 2003, all national parks and other protected areas (e.g., wildlife sanctuaries) in Thailand were administrated by the Royal Forest Department, the Ministry of Agriculture and Cooperatives.
2. Objectives.	-To preserve significant natural resources at the national level. - To manage for recreational and educational purposes.	- To preserve significant natural resources at national level. - To manage for recreational and educational purposes.	- Under the criteria that the national park has significance at the national level and belongs to everyone. - Chettamart, (undated), Pongroongsup, and Pitayakajornwute (1989), NPS (1999), MNPD (2000a). - However, most parks are primarily established for recreational purposes (Sellars 1997, Loomis

Appendix 5. (Continued).

			2002, Brennan and Miles 2003).
3. Park system.	-Uses a military system by setting up a single park area and establishing a clear perimeter separating it from the outside.	- Uses a similar system.	-The Thai national park system is largely based on the US model (Chettamart 2001a). - Thai national parks are separate from other protected area systems, e.g., wildlife sanctuary.
	- Sets up and controls areas under the laws provided.	- Set up and control under the laws provided.	- The IUCN system is similar to the US (see the comparison of the system on Appendix 6).
	- Separates terrestrial parks (National Park Service, NPS) and Marine Parks (the United States National Oceanic and Atmospheric Administration, NOAA).	-Both terrestrial and marine parks are under the same Office (National park Office).	- Before 1992, both terrestrial and marine parks were under the same division, but later were separated. After the restructuring of the Royal Forest Department in 2002, they are again under the same office (PWPCD

Appendix 5. (Continued).

			2003, MONRE 2003).
4. Management.	- Use the military approach.	- Use the military approach copying from the US system by establishing a headquarter and protection units around the national park boundary.	- In Thailand, park management is isolated from other types of protected areas.
5. Planning.	- Each park has it own management team. - Have the central office work together with staff from the regional office. - Planning is oriented toward managing areas inside the park boundary.	- Each park has it own management team. - Use the same approach. - Planning is oriented toward managing areas inside the park boundary by applying the US planning process.	- Both countries have similar problems with planning teams. For example, the planners from the central unit spend less time (Stankey personnal communication). - See the differences in concepts applied below.
6. Concepts applied (e.g., the ecological concept in setting up national parks).	- Apply significance of areas, resources existing (species), and purposes of	- Apply similar ideas and criteria from the US national park to establish	- Suggestion: conservation concepts, tools, and approaches (e.g., source-

Appendix 5. (Continued).

	management to establish and manage national parks.	national parks (Pongroongsup and Pitayakajornwute 1989).	sink population, gap analysis; see Chapter 2 and Appendix 1) can be applied to park design, expansion, and re-categorization.
7. Resource supports.	- Faces constraints in resources (e.g., man power, budget) support.	- Faces similar problems.	- But Thailand faces much more pressure from lack of support than the US. Many resources (e.g. man power, equipment) are used in protection work instead of research or recreation projects.
II. Differences: 1. Organization (s).	- Besides being administrated under the federal government, the US park system has other alternatives in management under state governments (e.g., state parks) and other federal agencies (e.g., national	-All national parks in Thailand are under one central agency: Park, Wildlife, and Plant Conservation Department (PWPCD 2003).	- The US has various agencies at different scales administrating parks in different types of forest categories (e.g., national parks by the National Park Service, state parks by park or forestry departments at the state

Appendix 5. (Continued).

	forestry managed for recreation by the USDA forest service, and managed by the Bureau of Land Management (Bean 2000, Loomis 2002, Brennan and Miles 2003).		level).
2. Policy.	- Use the national park policy as the main guideline of management (NPS 2000) and executive orders to lead management on the ground.	- Thailand has never had any formally written document of the national park policy at the national level (findings from the interviews in this study, but see Pongroongsup and Pitayakajornwute 1989), but uses laws (National Park Acts) as the main guideline (Chettamart 2001b), in combination with the directive orders from the Director General and the Director of the National Park Division.	- Though some may claim that there were policies related to protected areas (e.g., national parks) set up by the Royal Forest Department (at that time), or Directors of National Park Division, those were directive policies created by each director. - NPS. (1988, 2000).
3. Planning.	- The US Park Service	- Lack of EIS/EIA and	- The master plan in

Appendix 5. (Continued).

	includes the EIS/EIA process and people participation in the planning process.	people participation in the planning process.	Thailand is similar to the US management plan (Thorsell 1984, Pitayakajornwute 1984, NPS 1986, RFD 1990). - See why the plan does not work well in Thailand in Chapter 3 section 3.2.2 (3).
4. Management.	- Uses the military approach in park management, but park rangers spent more time on recreation work and research more on protection duties (see threats below).	- Uses military approach, but many park rangers have to spend most their time protecting areas from threats However, some park rangers work well on both recreation and protection.	- See the comparison of protected areas system in Appendix 6. - The differences in resources input and complexity ands severities of problems.
	- Use the concession approach to permit private sectors managing business (e.g., hotel, camp ground) in national parks.	- The government still controls most of the businesses is in the park.	- In Thailand, the discussion of co-management with the community is still going on.
	- The US system has	- The national park	- In this context, the

Appendix 5. (Continued).

	oversight committees in the congress as a check and balance mechanism.	division has a committee dealing with the setting up and abandoning of park areas, help resolve conflict resolutions, and other issues (e.g., giving advice to the director general) but the committee is not as powerful as the US system.	committee of the Thai national park system does not have any role in administrative nomination and management procedures. - For the oversight committees in the US, this is very important branch for managing natural resources in which management policy could benefit to particular groups in the society (e.g., politicians, influential people.
5. Concepts applied: recreation and ecological concepts applied in planning and management.	- Use recreation concepts such as ROS, LAC,VIM, ,VERP zoning, carrying capacity in park planning, recreation planning, and park management (Clark and Stankey 1979, Stankey et al. 1985, Graefe et al. 1990, Cole and McCool	-Use similar concepts such as zoning and carrying capacity in management. Though there were some studied on other concepts such as ROS (Ampholchan, 2000 a, 2000b), applications are still limited.	- For Thailand, conservation biology concepts (e.g., sources--sink, gap analysis) should be considered for on the ground testing.

Appendix 5. (Continued).

	1997, Hof and Lime 1997;Nilsen and Tayler 1997).		
6. Threats.	-Major threats are recreation activities, invasive species, and forest fire. Not many threats from illegal activities or resource extraction, but from legal activities such as land development, logging, building roads. - Problems with mass tourists (e.g., Yellow Stone National Park, ecological impacts, and underfund.	-Major threats are from resource extraction (illegal activities), land encroachment (both legal and illegal), forest fires, and others, (see threat analysis in Chapter 4, Table 1). - Problems from mass tourism from outside the country, tourist behaviors both from inside and outside the country.	-In the case where both countries face similar types of threats, the degree and scale of the threats in Thailand are usually higher than in the US. - In the US, most tourists go to national parks for education and recreation activities. In Thailand, most tourists go to have fun, Thai style (except for educational projects with schools, and specific groups of tourists).
7. Conflicts.	- Conflicts in land uses and management with recreationists and the public, e.g., snow mobile conflicts in national parks, or entrance fees in national	- Conflicts in land uses with local people, the public, other governmental organizations (e.g., boundary conflicts, land encroachment, land	- Though there are some similarities in land use conflicts (e.g., land development in some areas), patterns, agents, and degrees of conflicts are

Appendix 5. (Continued).

	forests. - Boundary conflicts are few.	development). - Boundary conflicts are in crisis. Many national parks still face with land encroachment, forest fire, and land development.	different. Most incidences in Thailand are of higher degree.
8. Research support.	- Use findings from research projects to guide park planning and management.	- Rely mainly on the protection approach. Applications of the findings from research are still limited.	-See future research in Table 10.
9. Conditions of management and uncertainty.	- Managers do not spend too much time in protection duties, except in fire and mass tourism seasons. Therefore, they have time to conduct the research.	- Managers have to spend most of their times in protection duties, leading to limited time in which to conduct research or take care of other duties.	- The differences in how managers spend time could potentially contribute to the level of success in applying concepts.
	- Still faces uncertainty in biology (e.g., global warming, invasive species).	-Faces uncertainty in biology, politics, social changes, economics, and invading from globalization.	- Though both countries face similar types of uncertainty, Thailand faces much more uncertainty in economics, politics, and

Appendix 5. (Continued).

	- Manage isolated parks.	-Manage fragmented, isolated, and small parks.	society than the US. - Both countries manage parks surrounded by hostile environment. Both also face problems about size, location, and connectivity of parks.

Appendix 6. A review of models of protected area management.

Model of Management	Objectives/ Ownership/ Management	Assumptions/ Criteria/Tools	Benefits	Limitations	Example/ Reference
US model	- Multiple objectives; i.e., protect natural resources, education, recreation, wildlife, etc.	- Multiple uses depending on the categories of areas and the organizations that manage them. - Use national significance as in national parks. Other agencies use similar criteria but different levels of significances. - Use zoning systems and other concepts (e.g., ROS, LAC) as major tools to manage parks (Clark and Stankey 1979; Stankey et al.	-Multiple objectives in one area. - Control of the areas. Good when used in areas having high conflicts. - Some areas are managed for recreations as the primary objectives (Brennan and Miles 2003).	- Impacts from human uses are unavoidable -Excludes people outside the park but allows people to gain experiences from recreations and education. -If areas are managed for recreation as the primary objective, an ecological objective may be ignored.	- Examples: national parks, wildlife refuges, state parks. (Sellars 1997, Loomis 2002, Brennan and Miles 2003).

Appendix 6. (Continued).

		1985; Graefe et al. 1990, Cole and McCool 1997, Hof and Lime 1997;Nilsen and Tayler 1997).			
	- Parks owned and managed by multiple agencies, with both federal and state governments.	- At the national level, based on the assumption that natural resources should belong to everyone in the country; therefore, the area should be managed by the government sector to guarantee equality.	- Parks owned by the government belong to everyone.		- Land owned by the National Park Service, all States of the US, and other US agencies that take care of land areas (e.g., USDA Forest Service, Bureau of Land Management).
	- Managed by multiple	- Governments or state agencies	- Governments can accomplish	- Limited resources (e.g.,	- Areas managed by the National

Appendix 6. (Continued).

	federal/state governments, or by private sectors (e.g., through concession).	have responsibilities to manage lands for the public benefit.	their responsibilities if they have enough resources (e.g., budgets), support, face fewer threats to Parks, and have public support.	budget) cause the government management to be ineffective.	Park Service, park departments or state agencies, other federal agencies (i.e., Forest service for national forest, BLM for range lands. Many parks managed by private sectors for recreation purposes through concessions, e.g., national parks in developed countries.
IUCN	- Protected area categories are set up based on the objectives of management (IUCN 1994).	- Assume that PAs could be managed to meet (multiple) objectives. - Consider the IUCN Red List data and other	- PAs can be managed to meet different objectives depending on the category of the PAs. - Provides	- Categories may work in some areas (countries), yet may not work in the others - The model does not suggest how to manage areas	- Categories 1-6 (IUCN 1994). -Now many concepts are being applied outside the park to ease the pressures and

Appendix 6. (Continued).

		international criteria (i.e., CITES) when setting up PAs. - Apply the zoning system and park management concepts (i.e., ROS, LAC, VERP, carrying capacity) to manage in some categories (i.e., category IV, national park).	various PA categories, and different categories could be managed to meet the same objectives.	outside PAs, instead excluding the outside from the management system.	threats.
	- Most PAs owned by the government.	- Similar reason to the US system: natural resources belong to everyone.	- Similar reasons to the US system.	- Areas owned by government may not guarantee management success. Some areas owned by local people may work better.	- Most protected areas under the IUCN system in the world owned by the government. A few of them are owned by local people or private

Appendix 6. (Continued).

					sectors.
	- Managed by government sectors, or organization which owns PAs.	- Similar reasons to the US system.	- Similar reasons to the US system.	- Some areas managed by the government may not accomplish the goals if lacking resources and support from the public. Other models of management may work better (i.e., community forestry, social forestry).	- Many PAs are managed by government sectors (i.e., most in developing countries), and many of them are managed by private sectors through concession (i.e. national parks in developed countries).
MAB	- Protect natural resources and provide areas for human uses by dividing protected areas into 3 zones (core, buffer, transitional	- By allowing people to use lands or extract resources in designated areas (buffer and transitional zones), it will decrease tensions	- A compromise approach. - The model can be used to decrease threats if people who gain benefits from using lands help the	- Zoning cannot stop people from using forestlands outside zoning areas, or from extraction natural resources from the core area. - Negative	- UNESCO (2002), Batisse (1982, 1997). - MAB areas all over the world (especially in developing countries) need to

Appendix 6. (Continued).

	zones).	and conflicts between government staff and local people. People may also help protect the areas. - Using zoning as a tool based on the assumption that people will limit their uses and follow the regulations provided in each zone.	government to protect natural resources.	feedbacks can occur when the more people get from protected areas, the more they want. Compromise that is expected to stop extracting natural resources may turn out to harm the core zones.	be evaluated on the effectiveness of the system and management.
	- Most areas are owned and managed by governments.	- Lands owned by the government are secure.	- Government owned can provide equality in access and uses by the public.	- In some area, private sectors may manage better.	- The model should be applied to private parks.
	- Most areas managed under	- Government sets up	- Equality when managed by the		- The model should be applied

Appendix 6. (Continued).

	government regulations.	the rules, so it's better to keep the regulations.	government.		to private parks.
Partnership model (i.e., ICDP, ICM and Tourism, Sustainable Forestry, Community Forestry, Community Based Management).	- To allow people participating in natural resources management.	- Based on an assumption that if the public or local people participate in management, they may help protect natural resources since they benefit from co-management. - By using other means or incentives (i.e. allowing people to extract natural resources, set up development projects to increase income), local people are less likely to rely	- People participation. - Decentralized approach. - Check and balance between tax payers and employees (government staff) - Economic incentives may increase incomes for local people in some areas.	- Conflicts of interests among groups of participations may occur. - Negative feedbacks from economic or development incentives may also occur. The approach may turn to negative impacts to the areas (i.e., instead of halting logging, people may log more because it is easy for them to access forests, or access to	- MacKinnon (2001), MacKinnon and Wardojo (2001), Chape (2001), Gray et al. (2001), Newmark and Hough (2000). - Participation management is a complicated and sensitive approach. Many factors are easily out of control of managers, or the committees who oversee the areas, (e.g., uncertainty, disconforming behaviors of

Appendix 6. (Continued).

		on natural resources. - From above reasons, increasing income may help to solve poverty problems and protect natural resources at the same time.		markets). If we allow local people to harvest non-timber forest products, local people may over harvest if they do in a massive scale (i.e., to export to other areas, or other countries). This may also persuade people from other areas to come to harvest more natural resources.	some influential people in the communities). - It's a nature of human that the more they get, the more they want. - People try to ignore their failures and think only of their benefit. Many times, ecological impacts are ignored and rarely mentioned in the management. - The scale of management is crucial. If economic incentives are managed at a small scale (i.e.,

Appendix 6. (Continued).

					for subsistence), the project is more likely to succeed, but managing at the larger scale (i.e., harvesting non-timber forest products for export to other countries), negative impacts are more likely to happen.
	- Most areas still belong to the government sector. In some countries, areas are now owned by communities.	- If areas are owned by the government, everyone in the society will have a chance to participate in natural resources management.	- If areas owned by communities, people in the communities may have a sense of belonging. They will use and protect natural resources as their own.	- If areas are owned by one community, other communities may not have a chance to benefits from the areas. - Failures or success depend on each community.	- The model, mechanism, or management is based on a case by case basis.

Appendix 6. (Continued).

				- In some cases, failure or success depends not only on its community but from outsiders (e.g., NGOs, international projects) in which it is risky.	
	- In the areas owed by governments, areas are co-managed between government agencies and communities or local people (but not solely by other interest groups in the society, e.g., private sectors).	- The public, in general, may gain broad benefits in areas owned by the government (i.e., watershed management project). Communities, in particular, may gain direct benefits from participation projects (e.g., extracting forest,	- Areas still belong to everyone in the nation. - Decreases pressures, or conflicts, between the government and the public.	-Conflicts may still exist among the parties of the public (e.g., different local people who benefits from protected areas.	- No best solution. It depends on a case by case basis.

Appendix 6. (Continued).

	In the areas owned by community, areas are mostly managed by communities, or coalitions (i.e., communities and government agencies).	harvesting non-timber forest products).			
Transboundary	- Multiple objectives (e.g., natural resources protection, security of the country). - Each country owns its protected areas. - Each country manages its own system.	- Based on an assumption that co-management between countries would increase capacity and efficiency of protected area management. -Criteria used depend on protected area categories in each country. - Tools used are	- Ecological benefits: protect and increase habitats for wildlife species across the borders, as well as co-management at the large scale. - Economics benefit: Ecotourism. - Political and security benefits	- Complexity of problems resulting from the differences in politics, economics, culture, socials, and protected area system and management. - The differences in legal status and management approaches of protected areas in	- Use the agreement on transboundary management between countries. - Transboundary committees at different levels can help solve conflicts from implementation. - Sandwith et al. (2001).

Appendix 6. (Continued).

		varied in each country.	for related countries.	each country, e.g., protected units adjacent to each other are managed differently. - Uncertainty of situations between countries, e.g., wars in one country or drug trafficking along the borders between countries.	
Private	- Give responsibilities to the private sector to help the government in taking care natural resources. - In some cases, private	- Based on the assumptions that private sectors can help governments protect natural resources. In some cases, private sectors	- Decreases the cost of conservation for the government sector. - Participation in natural resources management from other	-In some cases, private sectors target economic benefits over ecological impacts. - Some quality control and legal issues might	- In some cases limiting access by the public may create problems between the private sector and the public. - Segregate

Appendix 6. (Continued).

	companies can generate income and jobs for local people (e.g., tour guides, selling souvenirs, employees of business operated in the forest areas). -Most forest areas still belong to government, and private sectors get the concessions to manage the areas. There are some cases in which the lands belong to private sector.	may mange better than the government (e.g., tourism). - Another assumption is that conservation can go along with economics.	sectors (i.e., private companies). - For some reason, anything which belongs to private sectors has better protection since local people are afraid to encroach private property.	emerge if the government cannot request private sectors to minimize environmental impacts resulting from recreation activities.	problems; i.e., the cost of using areas or accommodations are high. Ordinary people who receive low incomes cannot afford to use the facility or areas. - Gustanski and Squires (2000).

Appendix 7. Patterns of reserve management.

Patterns of Reserve Management	Objective	Assumptions	Benefits	Limitations	References/ Examples
Strict reserve.	-Strictly protect natural resources inside nature reserve.	-Set up head quarter and Seattleites protected unit.	-Good to use in the area facing high illegal activity.	- No compromise, likely conflicts in the high pressures from human needs, lack of people participation in some cases.	- Example: IUCN category 1 (IUCN 1994).
Compromise model (e.g., MAB, ICM and Tourism, ICDP, Community Forestry, Community Based Management).	- To protect natural resources inside and allow people used in the buffer zone and transition zone.	-Based on three zone: Core, buffer, Transition.	-Compromise approach.	-Difficult to control zoning areas and to limit human uses.	- Example: MAB, IUCN category 4-6, US System (IUCN 1994, UNESCO 2002).
	- To develop level of economics for people who live around the PA and protect natural resources	- Under assumption that people have enough income, they will less likely to rely	- Generate work and incomes from outside PA.	- Positive feedback: the more people get, the more people need. No guarantee for stop illegal activities.	- ICDP (development & economic incentives). (See ICDP in Appendix 6).

Appendix 7. (Continued).

	in the PA. - Allow local people to join PA management processes.	on PA. - People participations could lead to less conflicts.	Decentralization people participation, People gain direct (i.e., to be park worker) and indirect benefits (i.e., join decision making).	- No boundary of human needs. In some cases, the more community get, the more people uses.	- Community forestry, sustainable forestry.
Private reserve.	-Allow private sector to manage PA with concessions.	- When private sector gain benefits, they are more likely to protect natural resources in a good conditions.	- Give responsibility to private sectors. Good for the government sector that have limited resources to manage forest.	- Quality control of resources use. In some case private sector may concern economics target than taking care natural resources.	

Appendix 8. Proposed models of protected area management.

Proposed Model of Management	Objectives	Assumptions	Benefits	Limitations
Individual reserve.	- Protect biodiversity in the protected areas. - Protect important habitats.	- By setting up a reserve, it would harbor existing biodiversity inside.	- Reserves would be genetics resources and provide ecosystem services to human society.	- Most reserves are isolated and small. - Most reserves face a high risk of threats, and are managed separately.
Networks (between reserves, whether the same or different categories).	- Protect habitats at the larger scale. - Harbor and enhance an existence of species at the larger scale.	- Based on the assumption that managing at the larger scale is more likely to protect many more species, and may have a chance to create a wider range of habitats for umbrella species. - Based on the assumption that to connect between reserves (i.e., corridors, stepping	- Management areas cover many habitat types (habitat variety). - Larger areas (size). - Connections between areas.	- How far between reserves? - How large should the corridors and stepping stones be? - Pressure from threats between PAs.

Appendix 8. (Continued).

		stone) would provide habitat and facilitate movement for species (i.e., existing species in a degraded area, migratory species).		
Mosaic (1) between different protected area categories; (2) between different land ownerships (i.e, government and private parks).	- To protect a variety of habitats and species in different categories or ownerships of protected areas. (e.g., mosaic among different protected areas such as wildlife sanctuary and national park).	- Assumes that different categories or ownership of protected areas located next to each other are still vital, important parts of a reserve system.	- Mosaics among different protected areas and ownerships could harbor threats for each other.	- A mosaic exists among different protected areas or ownerships: different categories of protected areas are managed differently (i.e. allowing people use national parks but not strict reserves in Thailand). Managing one reserve may impact adjacent reserves. - Categories or ownership conflicts may occur. For example, if reserves

Appendix 8. (Continued).

				in different categories are managed by different agencies, the conflicts and difficulty between organizations may limit the efficiency of reserve management or protection.
Matrix (reserve-non-reserve).	- Protect biodiversity both inside and outside reserves.	- Both a reserve or a non-reserve could help protect biodiversity. - Both a reserve or non-reserve could be a source or sink for species.	- Protect species and habitats both inside and outside protected areas. -Protecting habitats outside protected areas may harbor habitat inside protected areas from threats.	- Conflicts in management, objectives, or ownerships may occur.

Appendix 9. Models of management by objectives.

Model of management	Protect natural resources and genetics	Decrease threats/ pressures	Support subsistence	Increase economics	Ecosystem health and service	Compromise/ conflict resolutions	Human activities
US model	*	**	***	***	*	***	*****
IUCN	*	**	** (Category 4-6)	** Category 4-6)	*	** (Category 4-6)	** (Category 4-6)
MAB	**	*	**	**	**	*	**
Partnership model (i.e., ICDP, ICM and Tourism)	**	***	**	*	**	*	**
Transboundary	*	**	***	****	**	*	***
Private model	**	****	*****	*	***	***	*

Appendix 9. (Continued).

Remark: Importance and applicability of objective of management to a given model.

* = Primary objective

** = Secondary objective

*** = Possibly; case by case, or not in theory but could be practical

**** = Not very important, but applicable

***** = Not applicable

Appendix 10. Models of management by reserve types, scale, and target of management.

Model of management	Reserve type	Areas of management for single reserve	Areas of management for reserve networks	Scale of management	Target of management
US model	IR4 NR4	IN4 BA4 OR2	FR3 CN3 MN3 MA2	LS4 LA3 RS3 CS3	SP4 AR4 EC4
IUCN	IR4 NR4	IN4 BA4 OR2	FR3 CN3 MN3 MA2	LS4 LA3 RS3 CS3	SP4 AR4 EC4
MAB	IR4 NR3	IN4 BA4 OR4	FR4 CN4 MN4 MA2	LS4 LA3 RS2 CS2	SP4 AR4 EC2
Partnership model (i.e., ICDP, ICM and Tourism, Sustainable Forestry)	IR4 NR3	IN0 BA4 OR4	FR4 CN3 MN2 MA1	LS4 LA3 RS2 CS1	SP4 AR4 EC4

Appendix 10. (Continued).

Transboundary	IR3 NR3	IN3 BA3 OR3	FR3 CN3 MN3 MA2	LS3 LA3 RS3 CS3	SP3 AR3 EC3
Private model	IR4 NR3	IN1 BA2 OR2	FR3 CN3 MN3 MA2	LS3 LA3 RS3 CS3	SP3 AR3 EC3

Remark:

1. IUCN category 1-6.
2. Some special reserve types are not covered in this analysis. For example, world heritage sites can be the same category as one of IUCN categories (i.e., national park, wildlife sanctuary). Wetland management category is another example.
3. "Partnership model" is used for convenience in analysis to mean any conservation approach cooperated under local people and park managers (i.e., ICDP, community forestry, social forestry, etc).
4. "Private model" means any reserve managed by private sectors (may be owned by private, public, or government groups).

Scales of applicability of techniques of management to a particular aspect:

0 = Not applicable
1 = Probably can be applied under the same assumption
2 = Can be applied but needs more research

Appendix 10. (Continued).

3 = Can be applied
4 = Regularly used

Abbreviation:

Reserve type:
- IR = Individual reserve
- NR = Reserve network

Areas of management for single reserve
- IN = Inside reserve
- BA = Buffer/Transitional area
- OR = Outside reserve

Areas of management for reserve networks
- FR =Fragmented or isolated reserves
- CN = Continuous reserve networks (i.e., same categories)
- MN = Matrix reserve networks (i.e., different reserve categories)
- MA = Matrix areas (i.e., reserve vs non-reserve)

Scale of management
- LS = Local scale
- LA = Landscape scale
- RS = Regional scale
- CS = Continental scale

Target of management
- SP = Species
- AR = Area
- EC= Ecosystem

Appendix 11. Techniques of management by objectives.

Techniques of management	Protect natural resources & genetics	Increase no. of species	Decrease threats/ pressure	Support subsistence	Increase economics	Compromise/ conflict resolution	Ecosystem health and service
In situ (genetic reserve)	*	**	**	*****	*****	*****	**
Protected area (area control)	*	**	*	*****	****	*****	*
Protected area (single/ multiple species management)	*	**	**	*****	*****	*****	**
Protected area (ecosystem management)	*	**	***	****	****	*****	*
Buffer Zone	**	*****	**	***	***	*	**

Appendix 11. (Continued).

Connectivity (e.g., corridor, stepping stone)	*	*	****	****	****	**	**
Ex situ (zoo, botanical garden, DNA storage, field gene bank, seed/pollen storage)	*	*	**	****	***	*****	**
Introduced species	****	*	*****	*****	****	*****	*****
Translocation	**	*	****	*****	*****	*****	**
Partnership model (i.e., ICDP, ICM and Tourism)	**	*****	***	****	*	*	****
Restoration	**	*	****	*****	****	****	*

Appendix 11. (Continued).

Holistic management	*	**	****	****	****	****	*
Monitoring	*	****	**	*****	*****	*****	*
Threats management (i.e., fire, invasive species)	*	*****	*	*****	*****	****	*
Private reserve management	**	*****	**	*	*	*	**
Adaptive management	**	*****	***	****	****	*	**

Remark: Importance and applicability of objective of management to a given model.

* = Primary objective
** = Secondary objective
*** = Possibly; case by case, or not in theory but could be practical
**** = Not very important, but applicable
***** = Not applicable

Appendix 12. Techniques of management by reserve types, scale, and target of management.

Techniques of management	Reserve type	Areas of management for single reserve	Areas of management for reserve networks	Scale of management	Target of management
In situ (genetic reserve)	IR4 NR4	IN4 BA0 OR0	FR3 CN3 MN3 MA3	LS4 LA3 RS3 CS3	SP4 AR4 EC4
Protected area (area control)	IR4 NR3	IN4 BA4 OR3	FR4 CN4 MN4 MA3	LS4 LA3 RS3 CS3	SP4 AR4 EC4
Protected area (single/multiple species management)	IR4 NR3	IN4 BA3 OR2	FR4 CN3 MN4 MA3	LS4 LA3 RS3 CS3	SP4 AR3 EC3
Protected area (ecosystem management)	IR4 NR34	IN4 BA4 OR3	FR4 CN3 MN4 MA3	LS4 LA3 RS3 CS3	SP4 AR3 EC3

Appendix 12. (Continued).

Buffer Zone	IR4 NR3	IN2 BA4 OR4	FR2 CN2 MN2 MA3	LS4 LA3 RS3 CS3	SP1 AR4 EC3
Connectivity (e.g., corridor, stepping stone)	IR0 NR3	IN1 BA3 OR3	FR3 CN4 MN3 MA3	LS4 LA3 RS3 CS3	SP3 AR4 EC3
Ex situ (zoo, botanical garden, DNA storage, field gene bank, seed/pollen storage)	IR4 NR3	IN0 BA3 OR4	FR0 CN0 MN0 MA4	LS3 LA3 RS4 CS3	SP4 AR2 EC3
Introduced species	IR0 NR02	IN2 BA2 OR0	FR0 CN0 MN0 MA0	LS0 LA0 RS0 CS0	SP0 AR0 EC0
Translocation	IR2 NR2	IN2 BA2 OR1	FR2 CN2 MN2 MA2	LS2 LA2 RS2 CS2	SP2 AR2 EC2

Appendix 12. (Continued).

Restoration	IR4 NR3	IN4 BA4 OR4	FR4 CN3 MN4 MA4	LS4 LA3 RS3 CS3	SP4 AR4 EC4
Holistic management	IR4 NR3	IN4 BA3 OR3	FR4 CN3 MN4 MA3	LS3 LA3 RS3 CS3	SP3 AR3 EC3
Monitoring	IR3 NR3	IN3 BA3 OR3	FR3 CN3 MN3 MA3	LS2 LA3 RS3 CS3	SP3 AR3 EC3
Threats management (i.e., fire, invasive species)	IR4 NR3	IN4 BA4 OR4	FR4 CN4 MN3 MA3	LS4 LA4 RS3 CS3	SP4 AR4 EC4
Adaptive management	IR4 NR3	IN4 BA4 OR4	FR4 CN3 MN4 MA3	LS4 LA3 RS3 CS3	SP3 AR4 EC3

Appendix 12. (Continued).

Remark:

1. IUCN category 1-6.
2. Some special reserve types are not covered in this analysis. For example, world heritage sites can be the same category as one of IUCN categories (i.e., national park, wildlife sanctuary). Wetland management category is another example.
3. "Partnership model" is used for convenience in analysis to mean any conservation approach cooperated under local people and park managers (i.e., ICDP, community forestry, social forestry, etc).
4. "Private model" means any reserve managed by private sectors (may be owned by private, public, or government groups).

Scales of applicability of techniques of management to a particular aspect:

0 = Not applicable
1 = Probably can be applied under the same assumption
2 = Can be applied but needs more research
3 = Can be applied
4 = Regularly used

Abbreviation:

Reserve type:
IR = Individual reserve
NR = Reserve network

Areas of management for single reserve
IN = Inside reserve
BA = Buffer/Transitional area

Appendix 12. (Continued).

OR = Outside reserve

Areas of management for reserve networks

FR =Fragmented or isolated reserves

CN = Continuous reserve networks (i.e., same categories)

MN = Matrix reserve networks (i.e., different reserve categories)

MA = Matrix areas (i.e., reserve vs non-reserve)

Scale of management

LS = Local scale

LA = Landscape scale

RS = Regional scale

CS = Continental scale

Target of management

SP = Species

AR = Area

E C= Ecosystem

Appendix 13. Rapid assessment of protected area management effectiveness.

RAPID ASSESSMENT OF PROTECTED AREA EFFECTIVENESS

1. Name of Protected Area: ______________________
2. Address: ______________________
3. Area (km^2): ______________________
4. Date of Establishment: ______________________
5. IUCN categories: ______________________
6. Name and Position of Interviewee: ______________________
7. Name of Interviewer: ______________________
8. Date of Interview: ______________________

I. PROTECTED AREA (PA)

1. Structure

1.1 individual PA

(1) Reserve design		(1) Scientific approach (2) Ad hoc (3) Other (specify) ___
(2) Previous land use		(1) National forest (2) Private land (3) Other (specify) ___
(3) Size	PA (km^2)	(1) 0-25% of PA national average (2) 26-50% of PA national average (3) 51-75% of PA national average (4) 76-100% of PA national average
	Forest cover (% of PA)	(1) 0-25% (2) 26-50 % (3) 51-75% (4) 76-100%
(4) Shape		(1) Circular (2) Rectangular (3) Other (specify) ____

(5) Age

(1) < 10 years
(2) 10-20 years
(3) 20-30 years
(4) >30 years

Date of:
Set up ___
Expansion (1^{st}) ___
Expansion (2^{st}) ___ or more (specify) ___
Abandoned ___

(6) Location

(1) < 10 km^2
(2) 10 – 20 km^2
(3) 20-30 km^2
(4) >30 km^2

Nearest PA ___
Nearest road system ___
Nearest village ___
Nearest development project (specify) ___

(7) Existence of species

a. (1) Yes (2) No

b. No of species

(1) 1-5
(2) 6-10
(3) 11-15
(4) 16-20
(5) > 20

c. Status

(1) Extinct
(2) Rare
(3) Endemic
(4) Abundance

Categories	a	b	c	Remark
1. IUCN				
Threatened species				
Endangered species				
2. CITES				
Appendix 1				
Appendix 2				

3. Thai protected species				
4. Thai reserved species				
5. Other categories				
5.1 Representative species				
5.2 Focal species				
5.3 Indicator species				
5.4 Other (specify)				

(8) Level of significance of the PA
(1) Local
(2) Regional
(3) National
(4) International

1.2 PA System

(1) Connectivity
(1) Yes
(2) No

(2) If yes, what type of connectivity?
(1) Corridor
(2) Stepping Stone
(3) Other (specify) ___

(3) If yes, what type of forest areas are in (2)?
(1) PA
(2) Forest areas but not PA
(3) Private land
(4) Other (specify) ___

(4) If yes, how many other PAs are surrounding this PA?
(1) One
(2) Two
(3) More than three
(4) None

(5) Buffer zone
(1) Yes
(2) No

(6) If yes, how old?
(1) <10 years
(2) 10-20 years
(3) 20-30 years

(4) >30 years

2. Function

2.1 Protection functions

(1) Numbers of species contained
(1) Plants ___ species
(2) Wildlife___ species
(3) Other (specify) ___ species

(2) Level of significance (species)
(1) Local (endemic) ___ species
(2) National ___ species
(3) International ___ species
(4) Other (specify) ___ species

(3) Overall status of the groups of species addressed in (1)
(1) Intact
(2) Fairly intact
(3) Fairly degraded
(4) Degraded

(4) Vulnerability of the PA to threats (in a radius 10 km^2 radius)
(1) Number of village(s) ___
(2) Population ___
(3) Development project(s) ___
(4) Road ___ km^2
(5) Illegal activities __(cases/month)
(6) Other (specify) ___

(5) Level of vulnerability of the PA from threats (in a 10 km^2 radius) in (4)
(1) Low
(2) Moderate
(3) High
(4) Critical

Number of village(s) ___
Population ___
Development project(s) ___
Road ___ km^2
Illegal activities ___ (cases/month)
Other (specify) ____

(6). Level of severity of degraded lands

(1) Low (<5% of PA area)
(2) Moderate (5-10% of PA)
(3) High (10-15% of PA)
(4) Critical (>15 % of PA)

Inside the PA ___
Outside the PA (radius 10 km^2) ___
In the buffer zone (if any) ___

2.2 Biological Functions

(1) Number and list of species

(1) Keystone ___ species
(2) Umbrella ___ species
(3) Indicator ___ species
(4) Flagship ___ species
(5) Other (Specify) ___ species

(2) Other functions

(1) Wind break ___ species
(2) Fire brake ___ species
(3) Pest resistance ___ species
(4) Migratory habitat ___ species
(4) Other (specify) ___ species

2.3 Ecological Functions

(1) Explain the importance of the area in term of ecological service, i.e. watershed area)

____
____
____

(2) Level of overall ecological significance of the PA (i.e., watershed area, CO_2 Storage)

(1) Low
(2) Moderate
(3) High

Local ___
Regional ___
National ___
International ___

2.3 Composition

(1) Degree of complexity of each category in the PA

(1) Low
(2) Moderate
(3) High

Forest types ___
Habitat types ___
Wildlife specie ___
Geological Feature ___
Cultural value ___
Other (specify) ___

(2) Degree of overall complexity of all categories in the PA ___

Note: (Access the overall degree from a number of species, family, etc. in each category, compared to the national level)
Comment: ____
____

II. PROTECTED AREA MANAGEMENT

1. Structure

(1) Legal Status

(1) In the beginning of the preparation process (Not proposed to the legislature)
(2) In the middle of the preparation process (already proposed to the legislature and still in progress)
(3) Legal status

(2) Chain(s) of Command ___
(3) Adequacy of resources (Compare to the average of the division, department, international level; address any problems, suggestions, and future improvement).

Staff ___
Budget ___
Equipment ___
Infrastructure ___
Data and research support ___
Other (specify) ___

(4) Tools for management (i.e., GIS, Gap Analysis)
(5) Plan(s) (1) Yes
(2) No

Preliminary plan ___
Master plan or management plan ___
Annual plan ___
Other plan (specify) ___

2. Functions

(1) Management status (1) Well-managed
(2) Management in place
(3) Needs improvement
(4) No management

Inside the protected area:
Overall management status ___
Habitat management status ___
Species management status ___
Other (specify) ___

Outside the protected area:
Overall management status ___
Threats management status ___
Local involvement ___
NGO involvement ___
Other governmental organization ___
International Organization ___
The public ___
Expert (i.e., university researcher) ___

(2) Management projects (1) Yes
(2) No

Evaluation project ___
Monitoring project ___
Long-Term Ecological research project ___
Reforestation project ___
Land reform project ___
Rehabilitation project ___
Other restoration project (specify) ___
Other (specify) ___

(3) If yes for any project in (2), how well managed is it?
(1) Well-managed
(2) Management in place
(3) Need improvement
(4) Mismanagement

(3) Monitoring project
(1) Yes
(2) No

3. Composition

(1) Management techniques, tools, approaches
(1) Yes
(2) No

Ecosystem management ___
Watershed management ___
Community-based management ___
Agro-forestry ___
Fire protection ___
Cooperative project (specify) ___
Other (specify) ___

(2) If yes for any project in (1), how well management is it?
(1) Well-managed
(2) Management in place
(3) Needs improvement
(4) Mismanagement

(3) Management problems
(1) Well-managed
(2) Management in place
(3) Need improvement
(4) Mismanagement

Boundary __
Demarcation ___
Extension __
Abandon ___
National politics ___
Local politics ___
Influence from local authority ___
Other (specify) ___

Appendix 14. Indicators for the evaluation of the effectiveness of protected area system and management.

Aspect	Indicators	Measurement/Tools/Techniques	Remark
I. System A. Structures (Physical aspects).	1. Strength of areas (forests/ protected areas).	1.1 Number of representations. 1.2 Number of protected areas. 1.3 Percentage of forestland covered. 1.4 Reserve design (e.g., location, size, shape, connectivity, previous land uses).	- See rapid assessment (Appendix 13). -For 1.1, also consider efficiency or representation bias, or the level of irreplacibility of species or units that need to be included in the system. - For 1.2, compare numbers and sizes of units at different time scales, or compare in different conditions (e.g., level of protection of venerable habitats across regions). - For 1.3, compare between protected and unprotected areas, apply mapping, remote sensing, and Gap analysis, GIS.

Appendix 14. (Continued).

	2. Degree of threat (habitat loss & fragmentation).	- Number or percent increase of population growth, dams, roads, and other development projects.	- Compare at different time scales.
	3. Degree of vulnerability.	3.1 Degree of isolation (connectivity level). 3.2 Degree of vulnerability (how far from threats).	For 3.2, threats such as numbers of villages, road systems, development projects, land use (clearing, or conversion) in a radius 10 km^2 from protected areas).
	4. Degree of resistance.	4.1 Degree of tolerance to threat (e.g., disturbance). 4.2 Degree of tolerance (spatial scale: how much undamaged area), or measure levels of severity of degraded lands. 4.3 Complexity of areas (e.g., geological features, numbers of representations such as forest types).	-For 4.1, measure in different temporal scales; how long could the area tolerate a disturbance? - For 4.2, compare between damage and undamaged areas (e.g. before and after establish protected area, before and after human uses such as recreation activities). Apply remote sensing, or GIS, to compare or monitor.

Appendix 14. (Continued).

	5. Degree of resilience.	5.1 Degree of recovery (temporal scale: how long). 5.2) Degree of recovery (spatial scale: how much can be recovered).	
B. Functions (Biological & ecological services).	1. Protection functions.	1.1 Total area/species contained in the protected area. 1.2 Total critical areas/focal & surrogate species contained. 1.3 Level of significant of areas and species contained. 1.4 Resistance & resilience ability (i.e., CO2 releasing rate, forest fire). 1.5 Rate of extinction (if any), deforestation, fragmentation, habitat loss.	-For 1.3, at different levels (e.g., local, national, international). - For 1.4, compare past and present. - For 1.5, compare at different time scales (e.g., before and after establishing protected areas).
	2. Ecological functions.	2.1 Numbers of richness or rarity of focal species (indicators, umbrella, flagship, keystone). 2.2 Significance of areas (e.g., watershed, CO_2 storage, wind	- For 2.1, consider numbers of existing, reproductive/ regeneration, MVP. - For 2.2, consider areas that watershed function

Appendix 14. (Continued).

		brake, reproductive site, transmigratory site).	covers.
C. Compositions (Individual & Network)	1. Complexity of areas (e.g., disturbance, plants, animals, geological features, terrestrial and marine ecosystems). 2. Complexity of networks (e.g., adjacent protected areas, corridors, stepping stones).	1.1 Numbers of different representative. 1.2 Comprehensive measures such as configuration, environmental and geological variation. 1.3 Numbers (e.g., how many connectivity) and categories (e.g., connect with the same or different categories) of connectivity.	- Compare to different scales (e.g., regional, national). - GIS and gap analysis could be applied.
II. Management A. Structures	1. Legal status.	3.1 Measure legal status. 3.2 Adequacy of laws enforcement or existing regulations and provisions.	- See rapid assessment (Appendix 13). - (e.g., in the beginning of preparation process, in the middle of preparation process, legal status).
	2. Chains of command.	- Number of level of chain of command.	- No standard to compare with.

Appendix 14. (Continued).

	3. Adequacy and availability of resources.	3.1 Numbers of staff, equipment, infrastructures, data and research support. 3.2 Adequacy of financial support.	- Compare at different temporal scales (e.g., before and after establishment, every ten years). - Compare between categories, or different regions. - Adequacy of resources (3.1 and 3.2) could be compared to the standard at the international level. - Minimum requirements may vary in different regions and countries.
	4. Adequacy of tools.	- Existence and levels of implementation of the following tools: 4.1 Laws (e.g., national level), or regulations at departmental level. 4.2 Policy (e.g., protected area policy at national level), or policy for a specific category following national policy (e.g.,	- Existence: adequate, inadequate, moderate but need to be improved. - Levels of implementation (full implementation, no implementation, moderate implementation, and need to be improved).

Appendix 14. (Continued).

		national park policy). 4.3 Plan (e.g., national system plan, management plan, annual plan). 4.4 Supporting tools (e.g., GIS).	
B. Function.	1. Management status.	- Measure existing management status on different issues such as illegal logging, illegal extraction of non- timber forest products, illegal hunting, impact from recreation and tourism, development projects (golf course, dam, road construction), fires, pollution, immigration, and other (fishing, ranching). See Table 1 for threats to protected area.	- See rapid assessment (Appendix 13). - Measure at different levels (e.g., well managed, management in place, needs improvement, no management, mismanagement). Measure management inside protected areas, compare inside and outside in a radius 10 km^2 from the protected area. - Numbers of cases of illegal activity (caught, or unresolved) in different temporal scales could be applied to indicate the efficacy of management.

Appendix 14. (Continued).

	2. Management evaluation.	- Evaluate level of management input (economy), processes (efficiency), output (effectiveness), and outcome (effectiveness and appropriateness).	For this evaluation see Hockings (1997) and Hockings et al. (2000), (2002).
	3. Management programs	- Evaluate existing management programs such as environmental education, research programs, protection program, interpretation program, maintenance program, and outreach to community.	- Levels of success could be applied (e.g., success, no success, moderate success and need to be improved).
	4. Management projects	4.1 Apply management evaluation in 2 (above) to projects such as an evaluation project, monitoring project, long-term ecological/impact project, reforestation project, restoration project, or rehabilitation project. 4.2 Measures of success such as numbers of succeeded problem	- Levels of success could be applied (e.g., success, no success, moderate success and need to be improved).

Appendix 14. (Continued).

		solving, unresolved problems, or level of social acceptability.	
C. Compositions	1. Management techniques.	- Techniques such as ecosystem management, watershed management, all compromise approach (e.g., ICDP, ICM, community-based management), fire protection).	- Levels of measurement: well-managed, management in place, need improvement, no management, mismanagement.
	2. Management problems.	- Measure levels of management in different conditions, such as boundary conflicts, demarcation conflicts, extension projects, abandon project.	- Levels of measurement: well-managed, management in place, need improvement, no management, mismanagement. - Other conditions that could be considered in measurement are local politics, influence from local authority, and national politics.
	3. Information and database.	3.1 Use existing data to support management, e.g., biophysical information, socio-economic	

Appendix 14. (Continued).

		information. 3.2 Update existing information.	
	4. Degree of involvement.	- Measuring level of people participation, stakeholder involvement. - Level of success in cooperation with stakeholders, e.g., governmental organizations, private sector, NGOs, or the public.	- Apply level of success (e.g., success, no success, moderate success and need to be improved) and typology of participation (Pretty et al. 1995): passive participation, participation in information giving, participation by consultation, participation by material incentives, functional participation, interactive participation, and self- participation.