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A PROFILE OF THE ENDANGERED SPECIES OF THAILAND

Vol. 1. Through Birds.

James R. Bain and Stephen R. Humphrey

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This public document was promulgated at an annual cost of $1008.70 or $14.41 per copy to make available to all interested persons a report on the state of knowledge of the endangered species of Thailand.

Frontispiece: An Asian elephant (Elephas maximus) feeding in teak-bamboo forest in Changwat Kanchanaburi, Thailand. This individual is a work elephant, used in forest logging and maintained on forest forage. A sustained-yield exploitation system for both selective logging and elephant domestication could enable perpetual use of both forest and elephant resources while serving the internal economy of Thailand, but exploitation rates that maximize short-term profit probably would destroy the biological basis of both resources.

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Abstract.--A profile of the endangered and threatened species of Thailand is presented to provide state-of-knowledge information to land use planners. This is a demonstration of what can be accomplished using information in the files of the International Union for the Conservation of Nature and Natural Resources and its existing worldwide system of experts on endangered species, supplemented by work oriented toward a specific country.

The body of the report consists of lists of endangered and threatened species of Thailand, accounts of their biology and management needs, literature references, and a list of experts. In addition to species legally recognized as endangered, coverage is given for species shown to share such status by this state-of-knowledge review. Planners interested in a specific tract of land or type of habitat are provided transparent maps that can be overlaid on maps of species distribution to prepare a list of endangered species that should be expected in the project area. Then details in the accounts of 155 animal species assigned a status designation in this study can be consulted to learn what biological factors and management needs are relevant. This information can be used to plan site-specific field surveys to assess environmental impact of development projects or to develop natural resource management plans. An example is provided of a list of species expected to occur in the area of the proposed Mae Chaem Watershed Development Project.

Analysis of methods used in this project shows that the approach of literature search, correspondence with IUCN experts, and in-country interviews and site visits was effective. One unsolved problem was the large information gap on what species are endangered by rapid nationwide

deforestation. Detailed knowledge of the present-day distribution of vegetation types and life zones is crucial to successful presentation of information on the probable distributions of listed species, and hence to the quality of a planning tool of this nature.

The 13 species in most serious trouble (from extinct to probably extirpated from Thailand) exemplify the most serious problems. Of these, 2 lived in the swamp and marsh mosaic of the central lowlands, and 3 others also depended on wetlands. One each lived in dry dipterocarp forest, mixed deciduous-evergreen forest, and lowland evergreen forest. Five reached precarious status because of unregulated harvest, a contributing factor in some of the other cases as well. And 1 involved habitat loss in another country. Essential habitats ranked in order of importance based on the number of endangered or threatened species in them and the imminence of habitat conversion plans are wetlands; the Mekong River basin; tropical lowland evergreen forest; hill evergreen forest; dry evergreen, dry dipterocarp, and mixed deciduous-evergreen forest; mangrove forest; and the coastal rivers of southeastern Thailand.

Acknowledgements.--We are grateful to F. Wayne King, Deputy Chairman of the Survival Service Commission, for facilitating communication with IUCN experts throughout the project; his efforts made that process operate smoothly. We thank the many scientists of the SSC specialist groups, and other scientists active in Thailand to whom they directed us, who were prompt and cooperative in responding to our inquiries and contributing recent and unpublished information. Their efforts added substantial quality to the data base of the report. Many natural resource professionals and interested citizens in Thailand were extremely helpful in providing information and perspectives on species' biology, problems, and possible solutions. These individuals in Thailand and the SSC are included in the List of Experts in this report. We are appreciative of those who took time to show us Thai natural resources in the field--Boonsong Lekagul, Schwan Tanhikorn, Taweesak Trirawatpong, A.H.V. Sharma, Warren Brockelman, Doyle Damman, and Warren Evans. Terry Grandstaff of the USAID mission staff in Bangkok helped us visualize the role of foreign aid in development projects and gave us specific information on the nature of the Mae Chaem Watershed project. Flawless administrative support and clear direction was provided by David A. Ferguson of the U.S. Fish and Wildlife Service, James W. Corson of the Man and the Biosphere Secretariat in Washington, D.C.; and Molly Kux, Albert Prinz, and Jane Stanley of the U.S. Agency for International Development. Bess Abdulla and Chris N. Wilkins, University of Florida library, processed the many interlibrary loan requests. Gus Kovalik, Hume Library, University of Florida, gave our bibliographic

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INTRODUCTION

The objective of this work is to develop a profile of endangered and threatened species of Thailand as a demonstration project on providing existing information to land use planners. The general approach selected was to begin with information already compiled in the Red Data Books of the International Union for the Conservation of Nature and Natural Resources (IUCN). We gathered further information through the world-wide network of experts on the IUCN Survival Service Commission specialist groups and through first-hand contact with Thailand's knowledgeable government officials, university scholars, and private individuals. Additional information was gathered from the world's scientific journals and books. Rather than conducting new research--which would require years, the work of many scientists, and substantial funding--the intent of this project was to compile the existing information from diverse sources to determine the state of knowledge and to identify information gaps, based on a relatively modest investment of time and funding.

This report must not be construed as being critical of Thailand, her government agencies or officials, or her people. Like all countries, Thailand faces the realities of making available the limited resources of the earth to an ever-increasing number of people. Foremost among the competing land uses this implies is the often mutually exclusive choice of devoting a place to human economic enterprise or to the non-monetary economies of plants and animals sharing our biological community. The natural resource profession long ago concluded that the optimal solution

to this problem is to identify renewable resources useful to man and base as much of the human economy as possible on harvesting these species at a level that will not disrupt their genetically programmed replacement power; to use nonrenewable resources as conservatively as possible; to convert a portion of the land to alternative, intensive agriculture and industry for diversity and stability of the human economy, but keeping that portion low enough that essential natural resources remain as abundant as possible; and allocating a stable opportunity for survival to species that have no presently perceived resource value but have potential uses in the future, as well as real though perhaps intangible value because of their embodied beauty or intrinsic genetic complexity. Maintaining this balance is difficult, and in practice we often fall short of the ideal.

This report is an excercise in identifying some of these shortfalls or their symptoms. For almost every species here considered, enough is known to pinpoint or at least outline the problems. For each, we propose conservation measures that represent opportunities to solve problems. These are management practices that need implementation or information gaps that need to be filled. In a few cases of rare, migratory animals, both the problem and the solution are not entirely in Thai hands. More often, the resources needed by the endangered species occur in several political jurisdictions, and international solutions are required. Whatever the case, both the information about problems and their proposed solutions provide guidance in land use planning for Thailand's still-rich renewable natural resources.

USING THIS REPORT

The bulk of this report consists of the details of the lists of endangered and threatened species, accounts of their biology and management needs, and list of experts. We anticipate that biologists and those with a concern about a particular species will consult the appropriate technical details. However, land use planners and some biologists who are more interested in a specific tract of land or type of habitat would find that approach inefficient. For these purposes it will be more effective to use the see-through maps located in the envelope inside the back cover, overlaid on maps in the body of the report. Used with the map of original vegetation and deforested areas, one can learn what habitat types occur or occurred in the area of interest. Used with the maps of species' distribution accompanying the accounts of species biology and management, one can prepare a list of endangered and threatened species that should be or have been expected to live in the area of interest. With a list compiled of species expected in a project area, general impacts on them can be anticipated from the details in the species accounts. Specific impacts, however, can be evaluated only with site-specific field studies. The maps are of insufficient scale, and the data on which they are based are of insufficient accuracy, to determine definitively that a particular species or habitat is present in a land use project area. They are adequate to determine probable presence and therefore are useful tools in anticipating problems and planning site-specific field surveys.

TERRESTRIAL VEGETATION TYPES

To understand the distribution and habitat of endangered species, it is helpful to know the existing types of terrestrial vegetation. The original vegetation of Thailand is shown in Fig. 1 in simplified form, from a map by the Royal Thai Survey Department in the Resource Atlas of Thailand, Applied Science and Technology Corporation of Thailand, 1977. Shown as overlaid transparencies on Fig. 1 are deforested areas of 1963 (Royal Forestry Department) and 1972 (Resource Atlas of Thailand and Royal Forestry Department). The 1972 overlay fails to show extensive tracts of rubber plantations in peninsular Thailand as deforested. Loss rate of forest is quantified regionally by Myers (1980), including 1978 figures. Details and maps of the 1978 data are due to be published by the National Research Council in 1981.

Several useful publications on vegetation types are available (Christiansen 1979, Robbins and Smitinand 1966, Smitinand 1966, 1968, Smitinand et al. 1970, Whitmore 1975). The following summary is quoted from Lekagul and McNeely (1977).

> "Evergreen forests...can be divided into several types, including Tropical Evergreen Forest, Hill Evergreen Forest, Coniferous Forest, and Mangrove Forest....
>
> Tropical Evergreen Forest "occurs from sea level to 1000 meters in areas which have an annual rainfall of at least 2000 mm, fairly evenly distributed throughout the year; drier subtypes are found in areas with a seasonally dry climate but with high rainfall during the rainy periods.... Typical tree species include Streblus zeylanica, Hydnocarpus ilicofolius, Shorea vulgaris, Dipterocarpus costatus,

1963

1972
Deforested
Areas

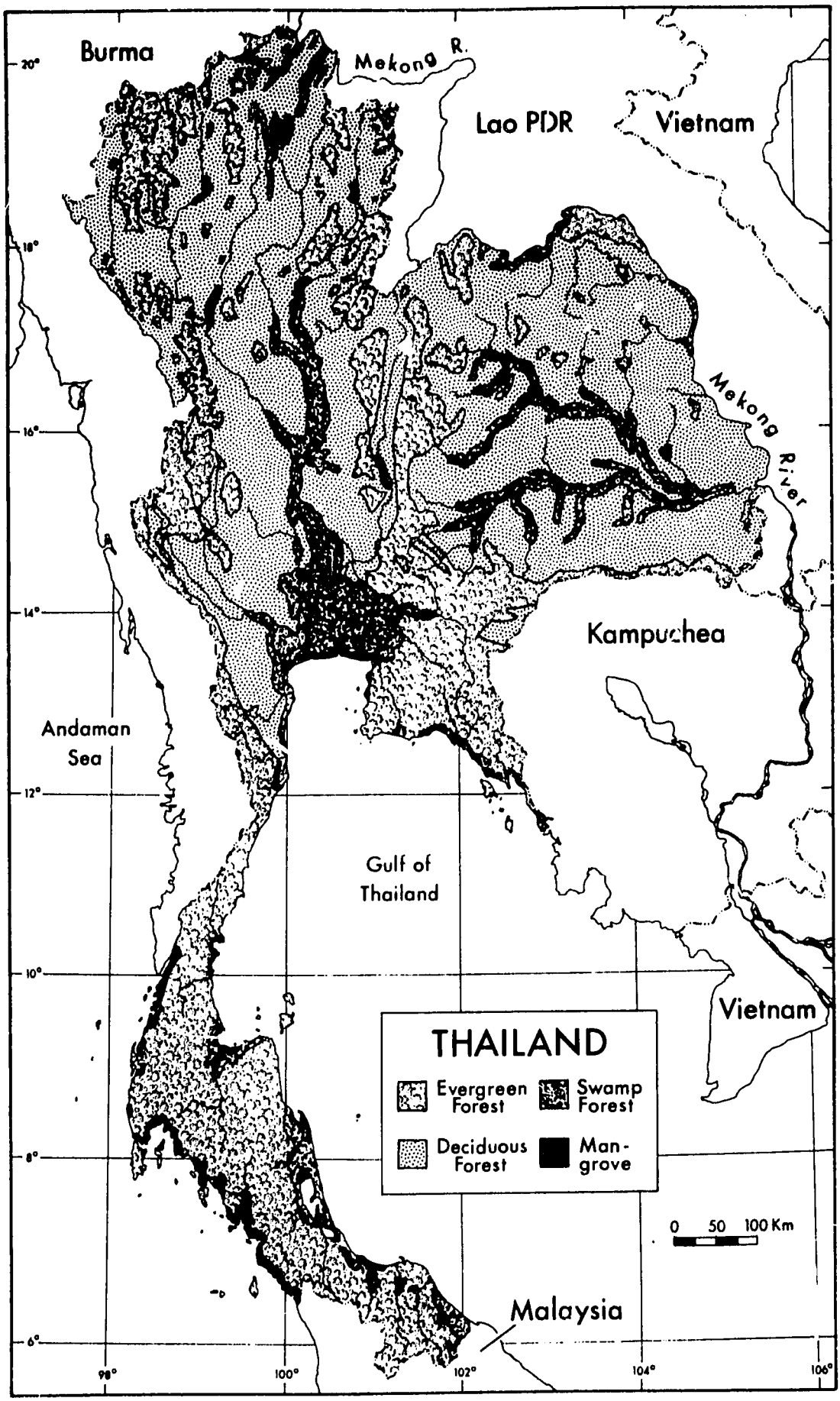


Figure 1. Original vegetation of Thailand.

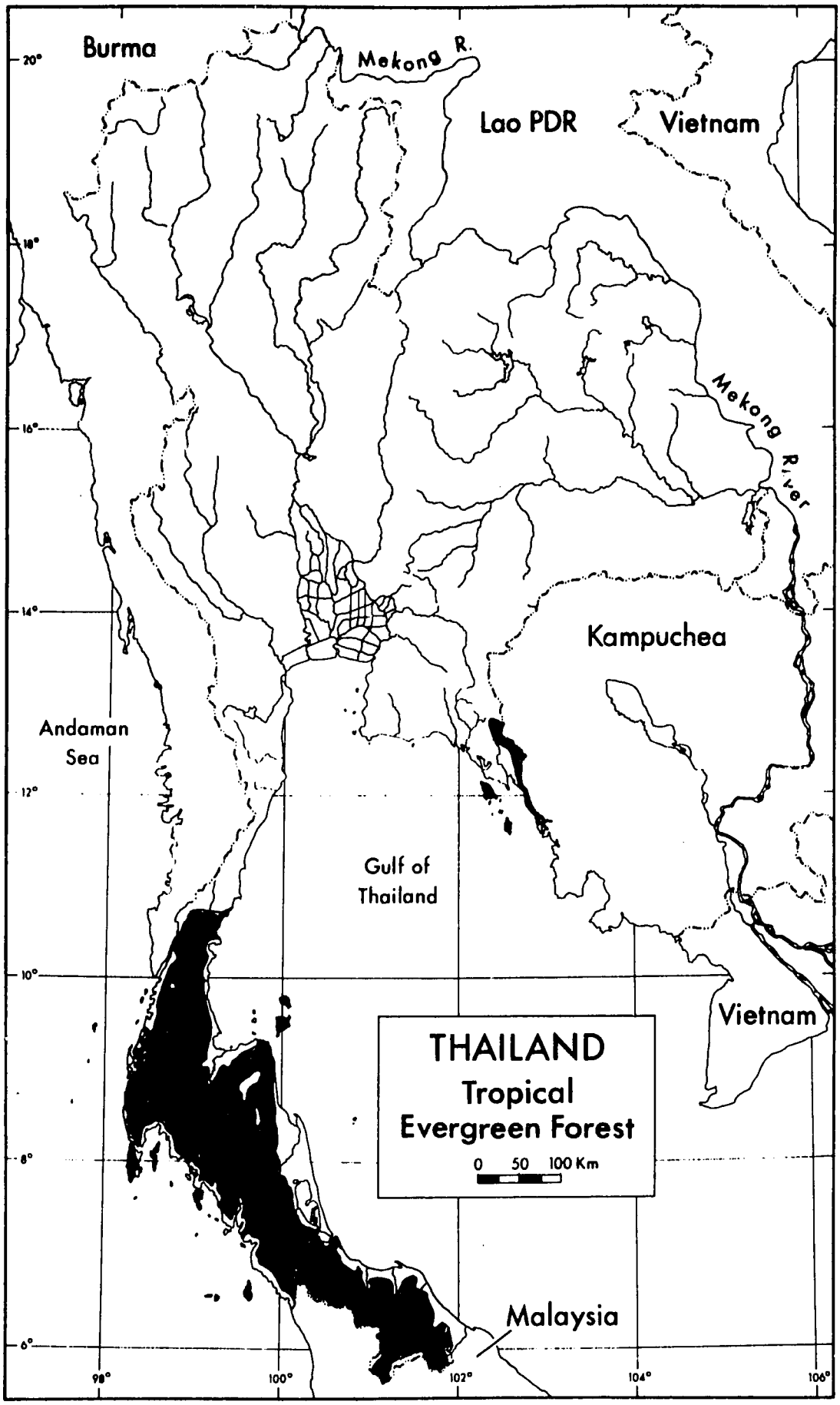


Figure 2. Distribution of tropical evergreen forest in Thailand.

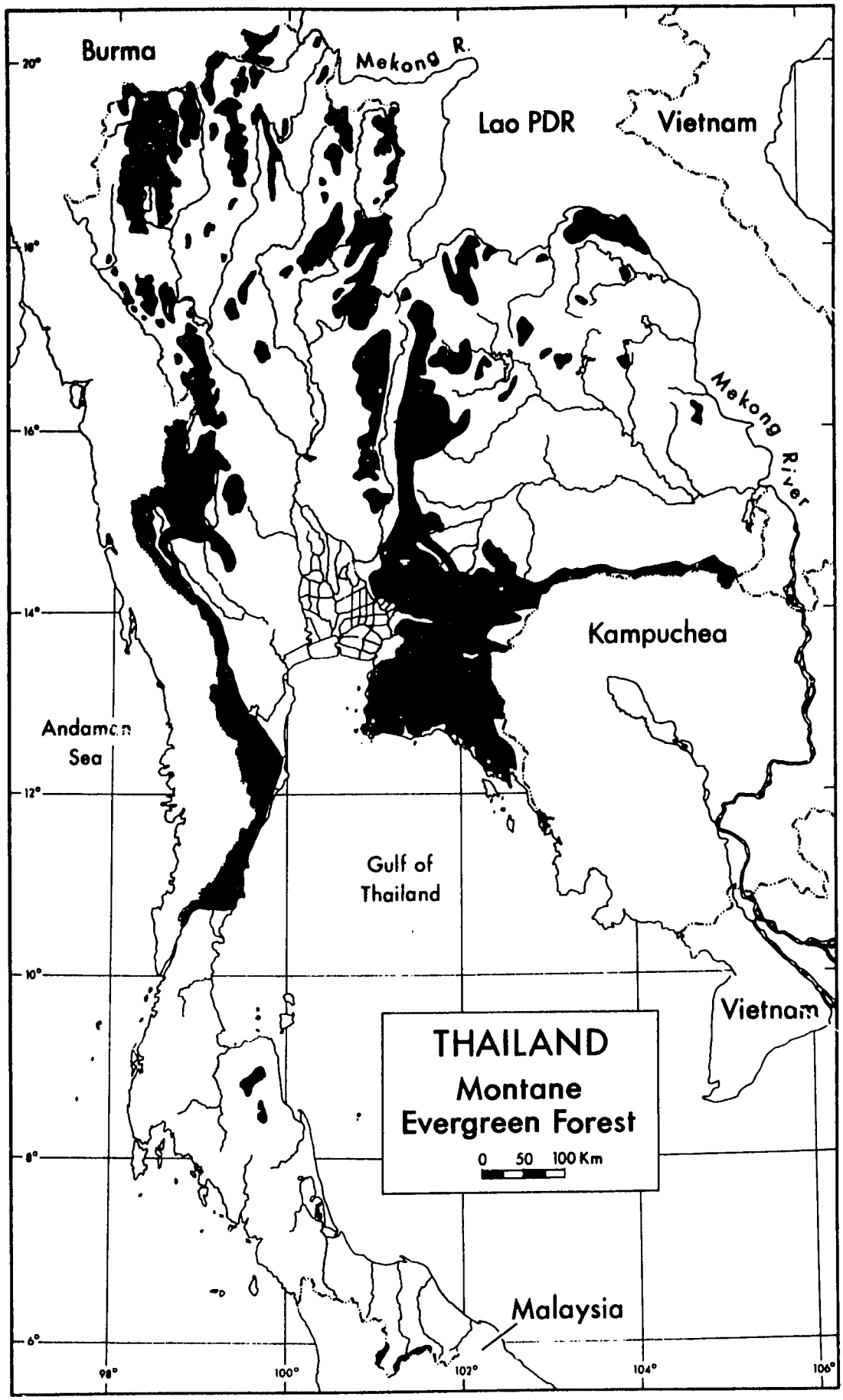


Figure 3. Distribution of montane evergreen forest in Thailand.

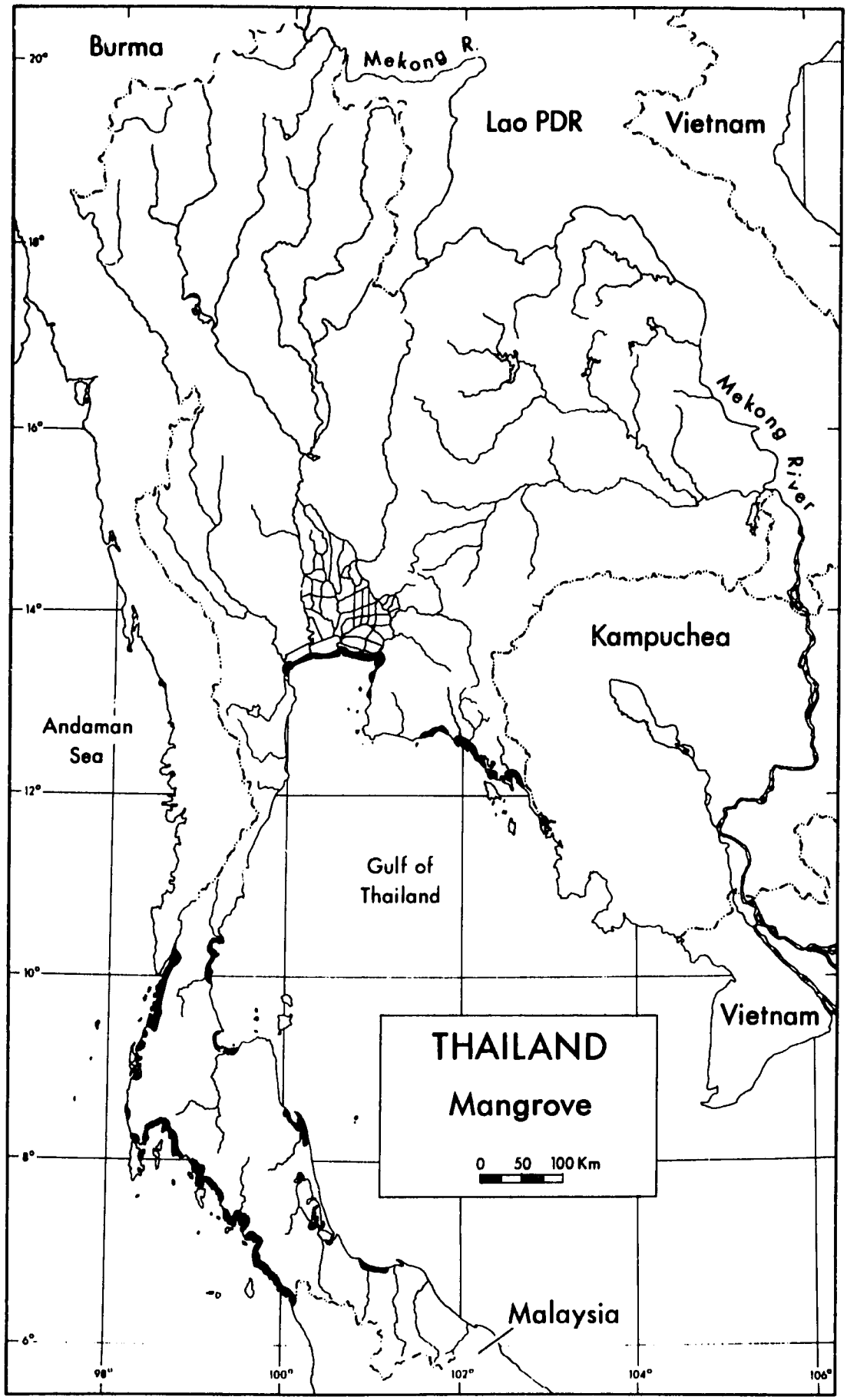


Figure 4. Distribution of mangrove forest in Thailand.

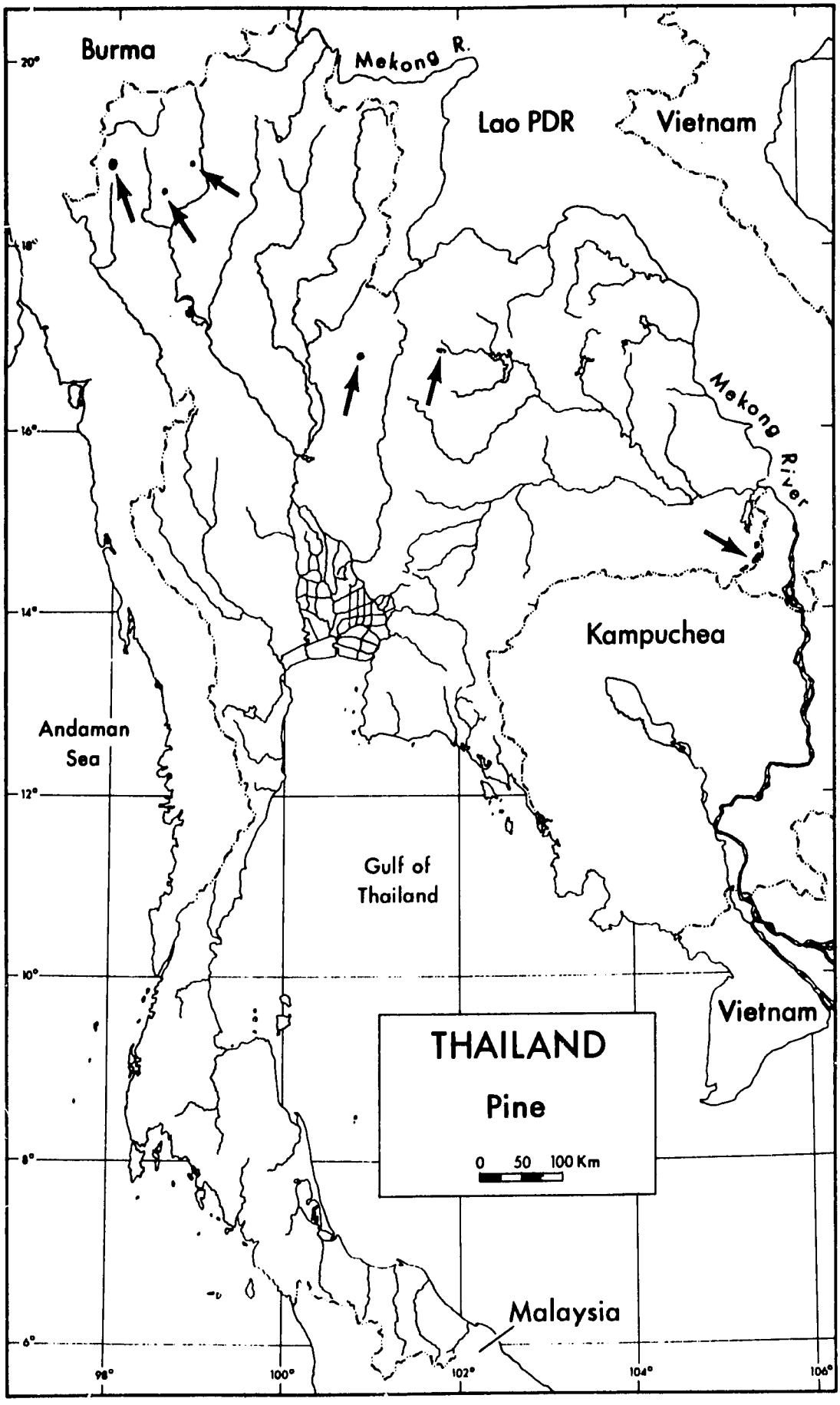


Figure 5. Distribution of pine forest in Thailand.

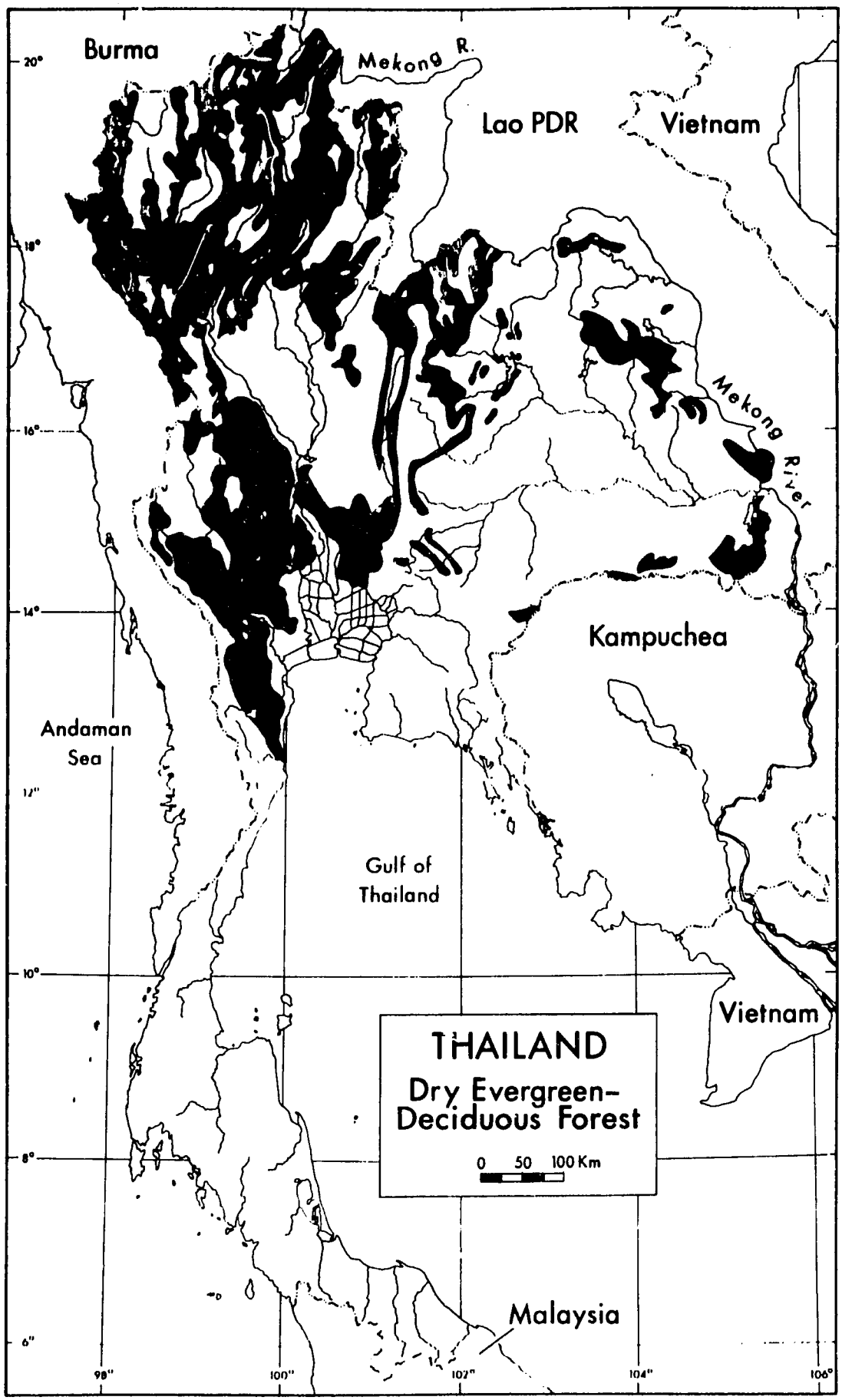


Figure 6. Distribution of dry evergreen/deciduous forest in Thailand.

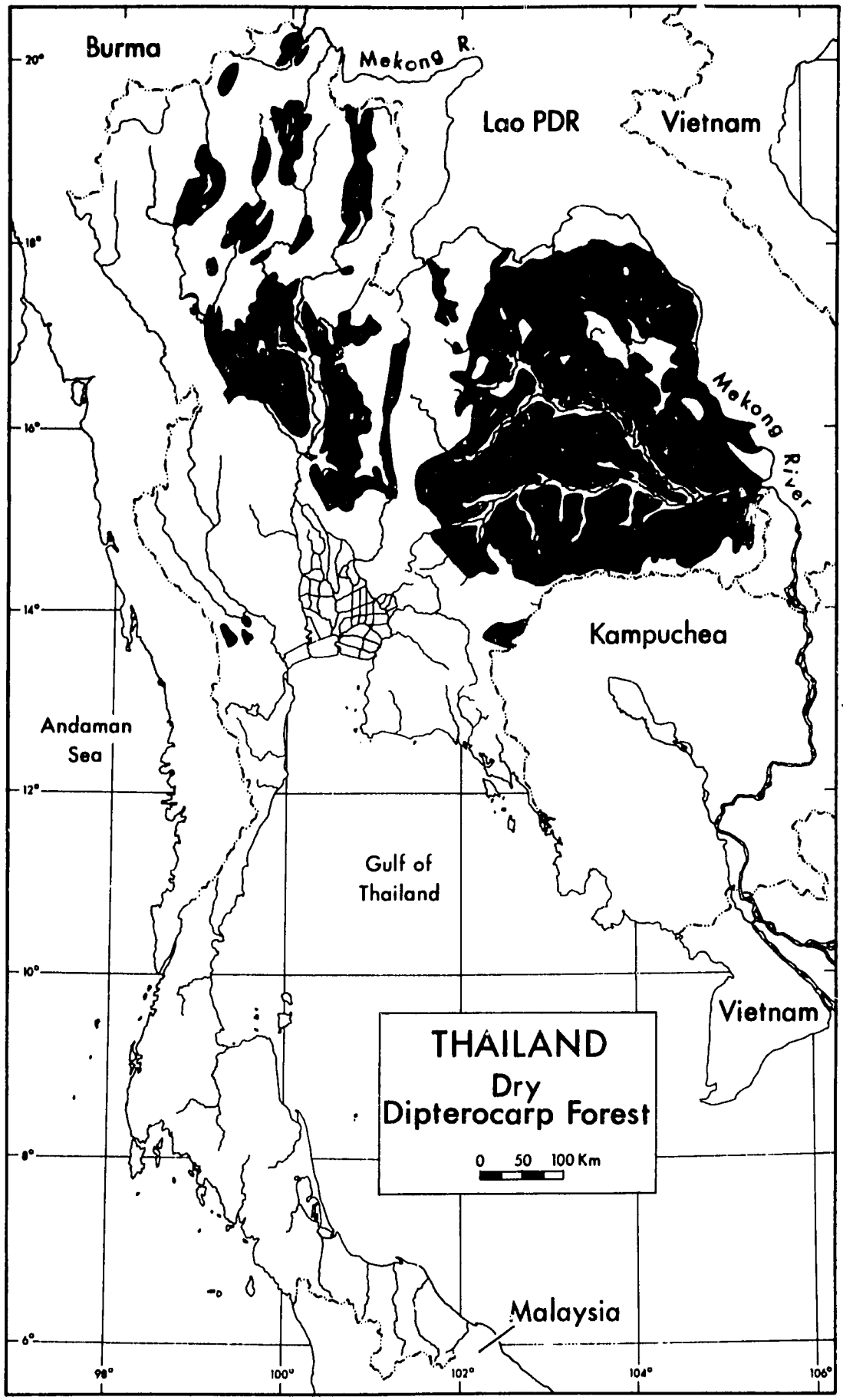


Figure 7. Distribution of dry dipterocarp forest in Thailand.

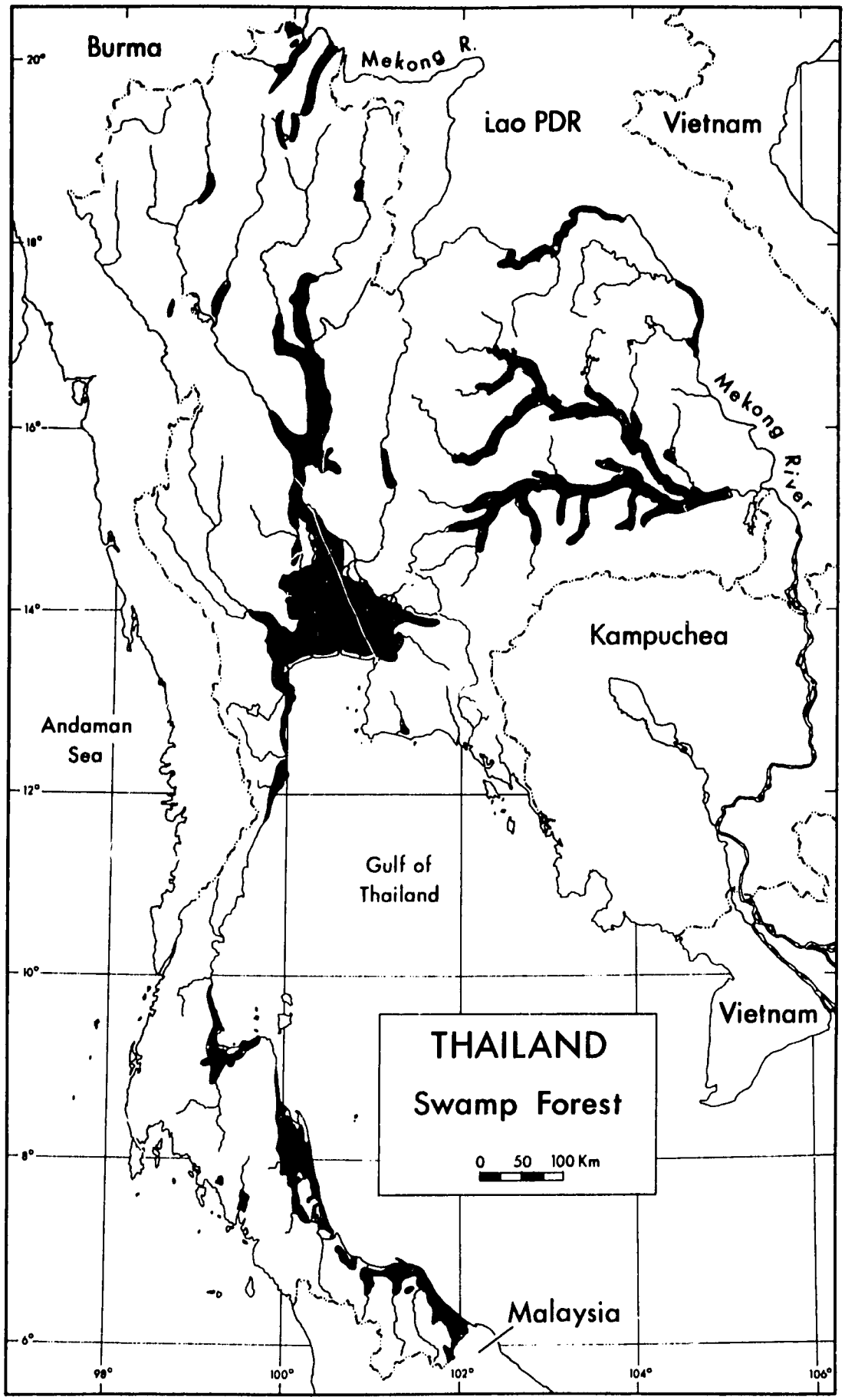


Figure 8. Distribution of swamp forest in Thailand.

Diospyros variegata, and Hopea recopei.... Evergreen rainforest...is found only in the far south (Yala, Songkhla, Narathiwat, Terutau Island), with perhaps a few small areas in Trang and Chantaburi. This subtype has the least seasonal variation in rainfall and the greatest floral diversity.... Semi-evergreen Forest...is found in the remaining parts of the peninsula below about 1000 m, north to about the level of Chumphon (11°N.), but extending slightly further north in the hills along the Burmese border.... Small areas of semi-evergreen forest also occur in the southeast.... Much the dominant form of tropical evergreen forest in Thailand is the Dry Evergreen Forest...It is found along the wetter parts of the Tenasserim range from Chumphon north to Chiengrai; along the Dangrek range to Khao Yai National Park; in the Petchabun range north to the Lao border; in the northeast; in the Phu Phan range in Sakhon Nakhon; and in northern Nong Khai along the Mekong River. Dry evergreen forest typically occurs mixed with bamboo, mixed deciduous forest, and scattered fire-climax grasslands...

"Hill Evergreen Forest occurs above 1000 meters, in areas where annual rainfall exceeds 2000 mm and is fairly evenly distributed throughout the year. This type of forest...is found in Thailand on the upper slopes of Khao Soi Dao in Chantaburi, the higher parts of Khao Yai and and Petchabun range, in the upper parts of Chiengmai, Chiengrai, Yak, and Mae Hong Son, and on the upper slopes of the Khao Luang range in Nakhon Si Thammarat and Surat Thani in the south (the southern hill evergreen forests should probably be considered a separate sub-type)...The dominant trees are oaks and chestnuts (Quercus, Lithocarpus, Castanopsis)....

"Mangroves are found only in fairly well-protected areas on mudflats between the level of the peak spring tides and the lowest neap tides," especially on "the west peninsular coast from Ranong to Satun.... Less extensive mangrove areas include the southeast coast (Trat, Chantaburi, Rayong) and the Chao Phya delta (Samut Songkhram to Chonburi)...; the peninsular east coast...mostly between Surat Thani and Pattani; and there are small patches of mangroves on many offshore islands.

"Coniferous forest is typically found in Thailand on sandy soils at elevations of 400-1400 meters, though there are a few groves in the plains and along sea coasts.

They consist mostly of two species of pines, Pinus khesya (insularis) (kesiya) and Pinus merkusii, with merkusii being more common and ranging lower in elevation. Pure stands of conifers are indicators of the controlling effects of fire;... Conifers are found in a fire climax on the summit plateau of Phu Kadeung in Loei Province, with others on the plateau of Phu Kheo in Chaiyaphum, Nam Nao National Park in the Petchabun range, and a few small patches in Sisaket, Surin, Ubon, and Loei.

"The deciduous forests of Thailand...can be divided into two main types, Mixed Deciduous...and Dry Dipterocarp....

"Mixed deciduous forest is found in areas receiving 1250 to 2000 mm of annual rainfall, with well-pronounced wet and dry seasons; it occurs on a wide variety of soils, on the plains as well as in the hills up to 1000 meters.... Dominant tree species include Dipterocarpus alatus, Shorea obtusa, Hopea odorata, and (in parts of the north) Tectona grandis.... Mixed deciduous forests are widespread in Thailand, ranging from northern Chumphon throughout the country; they are dominant in the west and north and are very prominent in the Petchabun range, the Phu Phan range, and the Thai-Lao border area in Ubon....

"Dry Dipterocarp Forest replaces mixed deciduous forest as annual rainfall drops below 1250 mm and the dry season lengthens to six months. Soils are typically dry, lateritic, and shallow, lacking humus. These forests are more open than the mixed deciduous forests, with more grass and bamboo undergrowth; most are burned annually, but natural regeneration occurs fairly plentifully and often luxuriantly.... Typical tree species include Shorea obtusa Dipterocarpus obtusifolius, D. tuberculatus, and Pentacme siamensis.... Dry dipterocarp forest is dominant in the northeast...; extensive areas also occur in the northern part of the central plain (from Nakhon Sawan to Uttaradit), with a few patches in the southeast around Aranyaprathet and in the west around Kanchanaburi."

The areas of swamp forest in Fig. 1 have never been described carefully, probably because little of the original vegetation has been present during recorded history. As used by Whitmore (1975), the term

"freshwater swampforest" encompasses a heterogeneous array of habitats, including forest that may include Mallotus, Camnosperma, Metroxylon, and Alstonia; fire climax Melaleuca forest; open plains of sedge or grass; and even floating grass mats. This diversity of possibilities is concordant with early references and current opinions referring to forests, wet savannas, and plains, all probably differing in the ways they are controlled by various combinations of fire and flooding. These swamp/savanna habitats occurred on the floodplains of the Chao Phraya, Mun, Chi, and Mekong rivers and their tributaries, of smaller rivers of peninsular Thailand, and on the seasonally flooded land around Songkhla Lake. A severely cut-over remnant of Melaleuca-Alstonia forest remains around Thale Noi and a few other places bordering Songkhla Lake.

LISTS OF ENDANGERED AND THREATENED SPECIES

The list on which this report is based originated as those species enumerated in lists of the United States Fish and Wildlife Service (USFWS) relating to the Endangered Species Act of 1973, the Convention on International Trade in Endangered Species (CITES), the IUCN Red Data Books, The Thai Fisheries Act, and Thailand's Wild Animals Reservation and Protection Act. Additionally, we interpreted the scope of this study to prepare a new list reflecting our professional judgment of what species are endangered or threatened and of their current status in Thailand. As expected from the progressive nature of the processes leading toward extinction, our evaluation compared with pre-existing lists includes more species and often indicates more precarious status. Some caution is appropriate in remembering that our status designation refers only to Thailand, and a species could be endangered in Thailand but neither endangered nor threatened considering its overall range. Likewise, some species are extirpated from Thailand but are not extinct, remaining elsewhere in their range.

In that we found legal lists of endangered and threatened species to be conservative, we concurred in nearly all legal listings. In a few cases we were unable to find enough information to make an independent evaluation of current status. These cases are blanket listings by CITES of all species of falcons (7 in Thailand), parrots(7), owls (19), accipiters (37), and orchids (at least 858 species in Thailand). Presumably listing the accipiters is justifiable, as these forest hawks probably are threatened by

deforestation. Certainly some of the orchids are very common, favored by human activities, and should not be listed, whereas others are endangered by habitat destruction and trade. Hence these listings will remain awkwardly unjustified until data can be gathered to produce a more parsimonious list. We have attempted to continue this process by listing particular species for which data on status are available.

In one respect these lists are woefully inadequate. Thousands of species of plants and animals are endangered or threatened by nationwide deforestation. Some are not yet known to science, and for most whether they can survive in habitats modified by human activity is unknown. Therefore the information on which to base a listing decision is lacking. In several cases where a suite of closely related forms face similar threats and information gaps or time constraints prevented thorough coverage, as in the bird family Pittidae, one or a few species were selected to illustrate the problems of the whole group.

The plant list was compiled primarily from several IUCN reports and should not be taken as an authoritative summary of Thailand's endangered flora. With its extensive latitudinal and altitudinal range Thailand possesses a remarkably diverse and, in many respects, poorly understood flora. Before a definitive statement of the true endangered species of plants can be made, many man-years of effort need to be invested in basic systematic and field studies.

The various listing authorities use overlapping categories to designate species' status. Following is a key to these as abbreviated in our list and definitions of the status categories as assigned in this report.

USFWS 1980a:

E = Endangered.
T = Threatened.

CITES 1979:

I = Appendix I, threatened with extinction.
II = Appendix II, may become threatened with extinction.
III = Appendix III, species listed at the request of Convention nations.

IUCN Red Data Book:

E = Endangered.
V = Vulnerable.
R = Rare.
I = Indeterminate.

WARPA 1972:

R = Rare.

TFA 1947:

CF = Capture forbidden.

This study 1981:

Extnt = Extinct. No longer known to exist anywhere in the world.

PExtnt = Possibly extinct.

Extrp = Extirpated from Thailand. No longer known to exist in Thailand but still survives somewhere else in its range.

PExtrp = Probably extirpated from Thailand.

E = Endangered. Populations or distribution have declined so much that the organism may become extinct or extirpated in the near future unless corrective measures are taken.

T = Threatened. Populations or distribution are declining so rapidly that the organism will become endangered in the near future unless corrective measures are taken.

PLANTS

NAME (Family)	CITES 1979	IUCN 1979	IUCN 1968	PAGE
Aeginetia indica (OROBANCHACEAE)	-	-	T	
A. pedunculata (OROBANCHACEAE)	-	-	T	
Afgekia sericea (LEGUMINOSAE)	-	-	T	
Balanophora abbreviata (BALANOPHORACEAE)	-	-	T	
B. harlandii (BALANOPHORACEAE)	-	-	T	
B. fungosa (BALANOPHORACEAE)	-	-	T	
B. latisepala (BALANOPHORACEAE)	-	-	T	
B. laxiflora (BALANOPHORACEAE)	-	-	T	60
Buddleia macrostachys (BUDDLEJACEAE)	-	-	T	
Christisonia siamensis (OROBANCHACEAE)	-	T	T	
Delphinium stapeliosum (=D. altissimum) (RANUNCULACEAE)	-	T	T	51
Dendrobium scabrilingue (ORCHIDACEAE)	II	T	T	
D. formosum (ORCHIDACEAE)	II	T	T	
D. infundibulum (ORCHIDACEAE)	II	T	T	
D. tortile (ORCHIDACEAE)	II	T	T	
Dichiloboea acaulis (GESNERIACEAE)	-	-	T	
Eria ornata (ORCHIDACEAE)	II	T	T	
Gentiana australis (GENTIANACEAE)	-	T	T	
Geranium siamense (=G. lamberti) (GERANIACEAE)	-	-	T	62
Habenaria carnea (ORCHIDACEAE)	II	T	T	
Hemipilia calophylla (ORCHIDACEAE)	II	-	T	
Impatiens kerriae (BALSAMINACEAE)	-	T	T	

NAME (Family)	CITES 1979	IUCN 1979	IUCN 1968	PAGE
I. psittacina (BALSAMINACEAE)	-	T	T	
Luculia gratissima (RUBIACEAE)	-	-	T	63
Lyonia ovalifolia var. ovalifolia (ERICACEAE)	-	-	-	
Maxburretia furtadoana (PALMAE)	-	T	-	64
Melaleuca cajuputi (=M. leucodendron) (MYRTACEAE)	-	-	-	67
Mitrastemma yamamotoi (RAFFLESIACEAE)	-	T	-	68
ORCHIDACEAE (all 858+ Thai species)	II	-	-	
Pandanus obovatus (PANDANACEAE)	-	T	-	
P. calcis (PANDANACEAE)	-	T	-	
Paphiopedilum bellatulum (ORCHIDACEAE)	II	-	T	
P. godefroyae (ORCHIDACEAE)	II	-	T	
P. niveum (ORCHIDACEAE)	II	-	T	
P. sukhakulii (ORCHIDACEAE)	II	T	T	
Pedicularis rhynchodonta (SCROPHULARIACEAE)	-	-	T	70
P. siamensis (SCROPHULARIACEAE)	-	-	T	71
Phyllanthodendron mirabilis	-	T	T	
Primula siamensis (PRIMULACEAE)	-	-	T	
Rafflesia kunstleri (CYTINACEAE)	-	T	-	
Rhododendron ludwigianum (ERICACEAE)	-	T	T	72
Rhynchostylis coelestis (ORCHIDACEAE)	II	T	T	
R. densiflora (ORCHIDACEAE)	II	T	T	
R. gigantea (ORCHIDACEAE)	II	T	T	

NAME (Family)	CITES 1979	IUCN 1979	IUCN 1968	PAGE
R. retusa (ORCHIDACEAE)	II	T	T	
Sapria himalayana (RAFFLESIACEAE)	-	T	T	73
Sciaphila thaidanica (TRIURIDACEAE)	-	-	T	76
Senecio craibianus (COMPOSITAE)	-	-	T	
Thismia mirabilis (BURMANNIACEAE)	-	T	-	77
Trigonobalanus doichangensis (FAGACEAE)	-	T	T	
Vanda coerulea (ORCHIDACEAE)	I	T	T	
V. denisoniana (ORCHIDACEAE)	II	T	T	
V. hookeriana (ORCHIDACEAE)	II	T	T	
Veratrum chiengdaoense (LILIACEAE)	-	-	-	78

INVERTEBRATES

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
CRUSTACEA						
DECAPODA						
Emerita emeritus (Jakajantalay, Sea Grasshopper, Sand Crab)	-	-	-	-	T	79
INSECTA						
LEPIDOPTERA						
Bhutanitis lidderdalei (Bhutan Glory Butterfly)	-	-	-	-	T	82
Sticopthalma godfreyi (Godfrey's Junglequeen Butterfly)	-	-	-	-	T	84

VERTEBRATES

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
OSTEICHTHYES						
OSTEOGLOSSIDAE						
Scleropages formosus (Pla Tapad, Ikan Kelasa, Asian Bonytongue)	E	I	-	V (1977)	PExtrp	87
NOTOPTERIDAE						
Notopterus blanci (Pla Tong Lai, Featherback)	-	-	-	R (1977)	T	91
Notopterus borneensis (Pla Satu, a featherback)	-	-	-	-	E	94
CYPRINIDAE						
Macrochirichthys macrochirus (Pla Dab Lao, a carp)	-	-	-	-	T	96
Chela caeruleostigmata (no common name)	-	-	-	R (1977)	T	99
Catlocarpio siamensis (Pla Koho, Giant Carp)	-	-	-	-	E	102
Probarbus jullieni (Pla Yeesok, Carp)	E	I	-	I (1977)	T	105
Puntius sarana (Tapien, Barb, Olive Carp)	-	-	-	-	T	109
Balantiocheilos melanopterus (Pla Hang Mai, Burnt-tail Carp)	-	-	-	-	PExtrp	112
Labeo behri (Carp)	-	-	-	-	E	115
Xenocheilichthys gudgeri (Pla Nam Fai, Backwater Fish)	-	-	-	-	E	118
SILURIDAE						
Hemisilurus heterorhynchus (Catfish)	-	-	-	-	E	121
CLARIIDAE						
Prophagorus nieuhofi (Pla Duk Lampan, a walking catfish)	-	-	-	-	T	124
PANGASIIDAE						
Pangasius sanitwongsei (Pla Thepa, Sanitwongse's Catfish)	E	-	-	R (1977)	E	127

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
Pangasianodon gigas (Pla Buk, Giant Catfish)	E	I	-	V (1977)	E	130
LOBOTIDAE						
Datnioides microlepis (Pla Soua Taw, Triple Tails)	-	-	-	-	E	134
AMPHIBIA						
SALAMANDRIDAE						
Tylototriton verrucosus (Kingkha Nam, Ma Nam, a primitive salamander)	-	-	-	-	T	137
RANIDAE						
Rana fasciculispina (Spine-breasted Giant Frog)	-	-	-	-	T	141
REPTILIA						
PLATYSTERNIDAE						
Platysternon megacephalum (Tao Pulu, Tao Pulu Neva, Chinese Big-headed Turtle)	-	-	-	-	T	144
EMYDIDAE						
Batagur baska (Tao Kra Arn, Tao Charn, Tuntong, Saltwater Terrapin, River Terrapin)	E	I	-	E (1978)	E	147
Heosemys (Geomyda) spinosa (Tao Chak, Spiny Terrapin)	-	-	-	-	T	151
TESTUDINIDAE						
Testudo (Geochelone) emys (Tao Hok Luang, Six-legged Tortoise, Yellow Giant Tortoise, Chinese Land Tortoise)	-	II	-	-	T	154
CHELONIIDAE						
Lepidochelys olivacea (Tao Ta, Tao Sarai Ta Daeng, Tao Sung-gasee, Pacific Ridley's Turtle)	T	I	-	E (1975)	E	167

NAME (Common)	USFWS 1980a	CITES 1979	TFA 1947 or WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
Eretmochelys imbricata (Kra, Hawksbill Turtle)	E	I	CF	E (1975)	E	169
Chelonia mydas (Tao Tu Nu, Tao Saeng-atit, Green Turtle)	T	I	CF	E (1975)	E	171
Caretta caretta (Tao Ya, Tao Ta Le, Tao Charamed, Loggerhead Turtle)	T	I	CF	V (1975)	E	174
DERMOCHELYIDAE						
Dermochelys coriacea (Tao Ma Gueng, Leatherback Turtle)	E	I	-	E (1975)	E	176
TRIONYCHIDAE						
Pelochelys bibroni (Man Lai, Ta Pab Hua Gob, Griu Dao, Grau Kaew, a giant soft-shelled turtle)	-	-	-	-	T	178
CROCODYLIDAE						
Crocodylus porosus (Saltwater Crocodile)	E	I	-	V (1979)	PExtrp	183
Crocodylus siamensis (Siamese Freshwater Crocodile)	E	I	_	E (1975)	PExtrp	187
Tomistoma schlegelii (False Gavial)	E	I	-	E (1979)	PExtrp	190
VARANIDAE						
Varanus bengalensis (Bengal Monitor)	E	I	-	-	E	193
Varanus rudicollis (Red-headed Monitor)	-	II	-	-	T	195
Varanus dumerilii (Black Jungle Monitor)	-	II	-	-	T	198
BOIDAE						
Python molurus bivittatus (Burmese Python)	-	II	-	V (1975)	T	200
Python curtus (Blood or Short Python)	-	II	-	-	T	203

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
AVES						
PELECANIDAE						
Pelecanus philippensis (Spot-billed Pelican)	-	-	R	-	T	206
FREGATIDAE						
Fregata andrewsi (Christmas Island Frigate-bird)	E	I	-	V (1977)	E	208
ARDEIDAE						
Egretta eulophotes (Chinese Egret)	E	-	-	V (1977)	E	211
CICONIIDAE						
Ibis leucocephalus (Painted Stork)	-	-	-	-	E	214
Anastomus oscitans (Openbilled Stork)	-	-	R	-	T	218
Ciconia nigra (Black Stork)	-	II	R	-	T	222
Ciconia (Dissoura) episcopus (White-necked Stork)	-	-	R	-	T	225
Xenorhynchus asiaticus (Black-necked Stork)	-	-	R	-	T	227
Leptoptilos dubius (Greater Adjutant Stork)	-	-	-	-	T	229
Leptoptilos javanicus (Lesser Adjutant Stork)	-	-	-	-	T	231
THRESKIORNITHIDAE						
Threskiornis melanocephala (White Ibis)	-	-	-	-	T	233
Pseudibis papillosa davisoni (Black Ibis, White-shouldered Ibis)	-	-	-	I (1977)	PExtrp	235
Pseudibis (Thaumatibis) gigantea (Giant Ibis)	-	-	-	R (1977)	PExtrp	237
ANATIDAE						
Cairina scutulata (White-winged Wood Duck)	E	I	R	V (1977)	E	239
Sarkidiornis melanotos (Pet Hong, Comb Duck)	-	II	R	-	T	242
ACCIPITRIDAE						
All 37 Thai species	-	II	-	-	-	-

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
FALCONIDAE						
Falco peregrinus (Peregrine Falcon, Duck Hawk)	-	I	-	V (1979)	E	245
The other 6 Thai falcons	-	II	-	-	-	-
PHASIANIDAE						
Rollulus roulroul (Roulroul)	-	-	R	-	T	248
Lophura leucomelana (Kalij Pheasant)	-	-	R	-	T	251
Lophura nycthemera (Silver Pheasant)	-	-	R	-	T	254
Lophura ignita (Crested Fireback Pheasant)	-	-	R	-	T	257
Lophura diardi (Siamese Fireback Pheasant)	-	-	R	-	T	260
Syrmaticus humiae (Mrs. Hume's Pheasant)	E	I	-	R (1977)	E	263
Polyplectron bicalcaratum (Burmese Gray Peacock Pheasant)	-	II	R	-	T	266
Polyplectron malacense (Malay Brown Peacock Pheasant)	-	II	R	-	E	268
Argusianus argus (Great Argus Pheasant)	-	II	R	-	T	271
Pavo muticus (Green Peafowl)	-	II	R	V (1979)	T	274
GRUIDAE						
Grus antigone sharpii (Nok Karien, Eastern Sarus Crane)	-	-	R	-	Extrp	278
SCOLOPACIDAE						
Tringa guttifer (Spotted Greenshank)	E	I	-	I (1977)	E	282
Limnodromus semipalmatus (Asian Dowitcher, Snipebilled Godwit)	-	-	-	R (1977	T	285
LARIDAE						
Sterna zimmermanni (Chinese Crested Tern)	-	-	-	I (1977)	PExtnt	288

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
COLUMBIDAE						
Treron seimundi (Yellow-vented Green Pigeon)	-	-	-	-	T	289
Treron sphenura (Wedge-tailed Green Pigeon)	-	-	-	-	T	291
Ducula bicolor (Pied Imperial Pigeon)	-	-	-	-	T	294
Columba pulchricollis) (Ashy Wood Pigeon)	-	-	-	-	T	296
Columba punicea (Pale-capped Pigeon)	-	-	-	-	T	299
Caloenas nicobarica nicobarica (Nicobar Pigeon)	-	-	-	-	T	301
PSITTACIDAE						
All 7 Thai species	-	II (1981)	-	-	-	
STRIGIDAE						
All 19 Thai species	-	II	-	-	-	
BUCEROTIDAE						
Berenicornis comatus (White-crested Hornbill)	-	-	R	-	T	305
Ptilolaemus tickelli (Brown Hornbill, Tickell's Hornbill)	-	-	R	-	T	308
Anorrhinus galeritus (Bushy-crested Hornbill)	-	-	R	-	T	311
Aceros nipalensis (Rufous-necked Hornbill)	-	-	R	-	T	314
Buceros rhinoceros (Rhinoceros Hornbill)	-	II	R	-	T	316
Buceros bicornis homrai (Great Hornbill)	-	I	R	-	T	319
Buceros bicornis bicornis (Great Hornbill)	-	II	R	-	T	319
Rhinoplax vigil (Helmeted Hornbill)	E	I	R	I (1979)	E	322
All 14 Thai Hornbills	-	-	R	-	-	
PICIDAE						
Mulleripicus pulverulentus (Great Slaty Woodpecker)	-	-	-	-	T	325

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
Dryocopus javensis (White-bellied Woodpecker)	-	-	-	-	T	328
PITTIDAE						
Pitta gurneyi (Gurney's Pitta)	-	-	-	I (1979)	T	330
HIRUNDINIDAE						
Pseudochelidon sirintarae (White-eyed River Martin)	-	II	-	I (1979)	E	333
MUSCICAPIDAE						
Eupetes macrocerus (Rail-babbler)	-	-	-	-	T	337
Graminicola bengalensis (Large Grass Warbler)	-	-	-	-	Extrp	339
Pachycephala cinerea (Mangrove Whistler)	-	-	-	-	T	342
MAMMALIA						
CRASEONYCTERIDAE						
Craseonycteris thonglongyai (Kitti's Hog-nosed Bat)	-	-	-	-	T	345
CERCOPITHECIDAE						
Macaca nemestrina (Pig-tailed Macaque)	-	II	R	-	T	348
Macaca assamensis (Assamese Macaque)	-	II	R	-	T	351
Macaca arctoides (Stump-tailed Macaque)	T	II	R	-	T	353
Macaca mulatta (Rhesus Macaque)	-	II	R	-	T	357
Macaca fascicularis (Crab-eating Macaque)	-	II	R	-	T	360
Presbytis melalophos (Banded Langur)	-	II	R	-	T	363
Presbytis obscurus (Dusky or Spectacled Langur)	-	II	R	-	T	366
Presbytis cristatus (Silvered Langur)	-	II	R	-	T	368
Presbytis phayrei (Phayre's Langur)	-	II	R	-	T	370

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
HYLOBATIDAE						
Hylobates lar (White-handed Gibbon)	E	I	R	-	E	372
Hylobates pileatus (Pileated Gibbon)	E	I	R	E (1978)	E	376
Hylobates agilis (Agile Gibbon)	E	I	R	-	E	380
MANIDAE						
Manis javanica (Malayan Pangolin)	-	II	-	-	T	384
Manis pentadactyla (Chinese Pangolin)	-	II	-	-	T	387
SCIURIDAE						
Ratufa affinis (Cream-colored Giant Squirrel)	-	II	-	-	T	391
Ratufa bicolor (Malayan Giant Squirrel)	-	II	-	-	T	394
Petaurista elegans (Lesser Giant Flying Squirrel)	-	-	-	-	T	398
Aeromys tephromelas (Large Black Flying Squirrel)	-	-	-	-	T	401
Petinomys setosus (White-bellied Flying Squirrel)	-	-	-	-	T	404
Belomys pearsoni (Hairy-footed Flying Squirrel)	-	-	-	-	T	407
Pteromyscus pulverulentus (Smoky Flying Squirrel)	-	-	-	-	T	410
MURIDAE						
Eothenomys melanogaster (Pere David's Vole)	-	-	-	-	T	412
Hapalomys longicaudatus (Marmoset Rat)	-	-	-	-	T	414
Rattus remotus (Island Rat)	-	-	-	-	T	417
Rattus neilli (Neill's Rat)	-	-	-	-	T	419

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
Rattus hinpoon (Limestone Rat)	-	-	-	-	T	421
STENIDAE						
Sotalia plumbea (Plumbeous Dolphin)	-	I	-	-	-	423
Sotalia borneensis (Indonesian White Dolphin)	-	I	-	-	-	423
Sotalia chinensis (Chinese White Dolphin)	-	I	-	-	-	424
Steno bredanensis (Rough-toothed Dolphin)	-	II	-	-	-	424
DELPHINIDAE						
Stenella malayana (Malay Dolphin)	-	II	-	-	-	424
Delphinus delphis (Common Dolphin)	-	II	-	-	-	424
Tursiops aduncus (Eastern Bottle-nosed Dolphin)	-	II	-	-	-	425
Orcaella brevirostris (Irrawaddy Dolphin)	-	II	-	-	-	425
PHOCOENIDAE						
Neophocaena phocaenoides (Black Finless Porpoise)	-	I	-	-	-	426
PHYSETERIDAE						
Physeter catodon (Sperm Whale)	E	I(1981)	-	-	-	426
BALAENOPTERIDAE						
Balaenoptera borealis (Sei Whale)	E	I	-	-	-	426
Balaenoptera acutirostrata (Lesser Rorqual)	-	II	-	-	-	427
CANIDAE						
Canis aureus (Golden Jackal)	-	-	-	-	T	428
Cuon alpinus (Dhole)	E	II	-	V (1976)	E	434

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
URSIDAE						
Selenarctos thibetanus (Asiatic Black Bear)	-	I	-	-	T	438
Helarctos malayanus (Malayan Sun Bear)	-	I	-	-	T	441
MUSTELIDAE						
Mustela strigidorsa (Back-striped Weasel)	-	-	-	-	T	443
Lutra lutra (Common Otter)	-	I	-	-	T	449
Lutra (Lutrogale) perspicillata (Smooth-coated Otter)	-	II	-	-	T	453
Lutra sumatrana (Hairy-nosed Otter)	-	II	-	-	T	455
Amblonyx (Aonyx) cinerea (Small-clawed Otter)	-	II	-	-	T	457
VIVERRIDAE						
Prionodon pardicolor (Spotted Linsang)	E	I	-	-	E	460
Prionodon linsang (Banded Linsang)	-	II	-	-	E	462
Arctictis binturong (Binturong)	-	-	R	-	T	464
Hemigalus derbyanus (Banded Palm Civet)	-	II	-	-	T	466
Cynogale bennetti (Otter Civet)	-	II	-	-	T	469
FELIDAE						
Felis marmorata (Marbled Cat)	E	I	R	I (1978)	E	471
Felis viverrina (Fishing Cat)	-	II	-	-	T	473
Felis bengalensis (Leopard Cat)	E	I	-	-	T	475
Felis planiceps (Flat-headed Cat)	E	I	R	I (1978)	E	477
Felis chaus (Jungle Cat)	-	II	-	-	-	479
Felis temmincki (Asian Golden Cat)	E	I	-	I (1978)	T	481

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
Neofelis nebulosa (Clouded Leopard)	E	I	R	V (1978)	E	483
Panthera pardus (Leopard, Panther)	E	I	R	V (1976)	E	486
Panthera tigris corbetti (Tiger)	E	I	R	E (1978)	E	492
ELEPHANTIDAE						
Elephas maximus (Asian Elephant)	E	I	-	V (1978)	E	498
DUGONGIDAE						
Dugong dugon (Dugong)	E	I	CF	V (1976)	E	504
TAPIRIDAE						
Tapirus indicus (Malayan Tapir)	E	I	R	E (1973)	E	508
RHINOCEROTIDAE						
Rhinoceros sondaicus (Javan Rhino)	E	I	R	E (1976)	PExtrp	511
Dicerorhinus (Didermocerus) sumatrensis (Sumatran Rhino)	E	I	R	E (1976)	E	514
CERVIDAE						
Muntiacus feae (Fea's Barking Deer)	E	-	-	E (1972)	E	517
Cervus (Axis) porcinus annamiticus (Indochina Hog Deer)	E	I	R	-	PExtrp	520
Cervus schomburgki (Schomburgk's Deer)	-	-	-	-	Extnt	523
Cervus eldi (Eld's Brow-antlered Deer)	E	I	R	E (1972)	PExtrp	526
BOVIDAE						
Bubalus bubalis (Wild Water Buffalo)	-	III (Nepal)	R	V (1972)	E	529
Bos javanicus (Banteng)	E	-	R	V (1978)	E	532

NAME (Common)	USFWS 1980a	CITES 1979	WARPA 1972	IUCN RED DATA BOOK (DATE)	THIS STUDY 1981	PAGE
Bos gaurus (Gaur, Seledang)	E	I	R	V (1976)	E	536
Bos (Novibos) sauveli (Kouprey)	E	I	R	E (1976)	PExtnt	541
Capricornis sumatraensis (Serow)	E	I	R	-	E	544
Naemorhedus goral (Goral)	E	I	R	-	E	547

SUMMARY OF LISTED SPECIES AND THEIR ESSENTIAL HABITATS

The number of species listed and their status designations assigned in this study are given in Table 1. Analysis of essential habitats is restricted to the 155 individually listed species of animals, for which detailed biological characteristics are presented in the written accounts.

Examination of the species in most serious trouble (Table 2)--ranging from "extinct" to "probably extirpated from Thailand"--highlights the most serious or long-standing habitat changes. Schomburgk's deer is extinct. It lived in the mosaic of swamp forest and marsh of the lower Chao Phraya River basin, as did the extirpated large grass warbler. Three species that are probably extirpated--black ibis, giant ibis, and eastern sarus crane--also depended on wetland habitats. Other species lived in dry dipterocarp forest, mixed deciduous-evergreen forest, and lowland evergreen forest--Eld's deer, kouprey, and Javan rhinoceros, respectively. Five additional species, fish and reptiles, reached their precarious status because of harvest rates unregulated by fish and wildlife management practices, a contributing factor in some of the other cases as well. The Chinese tern's habitat problem is not in Thailand.

The listed species can be categorized into a few groups based on the habitat essential to their survival. Given in order of importance based on the number of endangered or threatened species in them and the imminence of conversion plans, they are wetlands; the Mekong River basin; tropical lowland evergreen forest; hill evergreen forest; dry evergreen, dry dipterocarp, and mixed deciduous-evergreen forest; mangrove forest; and the coastal rivers of southeastern Thailand.

Table 1. Number of species listed and their status designated in this study.

Group	Number of Species		Status Designation						
	Listed	Individually Listed	None Given	Extinct	Possibly Extinct	Extirpated	Probably Extirpated	E	T
Plants	893	53	893	-	-	-	-	-	-
Invertebrates	3	3	-	-	-	-	-	-	3
Fishes	16	16	-	-	-	-	2	8	6
Amphibians and Reptiles	20	20	-	-	-	-	3	7	10
Birds	126	51	75	-	1	2	2	10	36
Mammals	77	77	12	1	1	0	3	21	39
Total	1135	0	980	1	2	2	10	46	94

E = Endangered

T = Threatened

Table 2. Habitat required by Thailand's extinct and extirpated animals.

Status/Species	Habitat
Extinct	
Schomburgk's deer	swamp/marsh of the lower Chao Phraya basin.
Possibly Extinct	
Chinese crested tern	breeding habitat in China.
kouprey	mixed deciduous-evergreen forest in the dry season, evergreen forest in the rainy season.
Extirpated from Thailand	
large grass warbler	swamp/marsh of the lower Chao Phraya basin.
Probably Extirpated from Thailand	
Asian bonytongue	coastal rivers of southeastern Thailand.
burnt-tail carp	Chao Phraya River and its tributary rivers.
saltwater crocodile	estuaries and coastal waters.
freshwater crocodile	freshwater lakes, swamps, and rivers.
false gavial	unclear.
black ibis	lowland wetlands.
giant ibis	lowland wetlands.
eastern sarus crane	swamp forest/marsh wetlands.
Javan rhino	lowland evergreen forest up to 1000 m.
Eld's brow-antlered deer	dry deciduous forest, plains, marshes.

Wetlands. At least 20 species of listed animals require freshwater marshes, swamp forests, and associated habitats. Once an extensive component of the Thai landscape, nearly all marsh and swamp in the country has been drained and converted to agricultural uses. The only sizeable wetland known to remain is marshland and *Melaleuca*-*Alstonia* swamp around Songkhla Lake and Thale Noi in southern Thailand. Current threats include government housing projects, widespread illegal residences intended to establish personal ownership of government land, a proposed road, and deforestation for charcoal and building materials. A national inventory of potentially remaining wetlands is urgently needed, and existing remnants should be protected as wildlife refuges. Otherwise extinction or extirpation of these species will occur.

The Mekong River Basin. Twelve species of listed fishes occur in the Mekong River basin. Though overharvesting is responsible for the current plight of these fishes, a basinwide plan for developing agriculture and hydroelectric power now threatens these and many other species. A series of navigation channels and five mainstream dams will replace river habitat with reservoir habitat, destroy shoalwater habitat, prevent spawning of migratory fishes, and prevent spawning of non-migratory fishes in the seasonally flooded land that they require for breeding. A total of 23 fish species that are either migratory (Pantalu and Bardach 1969 in Mekong Committee 1976, Lagler 1976a) or else incapable of living in reservoir habitat (Lagler 1976b) are expected to be lost from the Mekong. The basinwide economic loss of protein resources, accounting for the anticipated reservoir fishery, is estimated at US $4-6,000,000 per year

(Lagler 1976b). Additionally, loss of the annual refertilization of existing agricultural land by the silt from annual floodwater will necessitate substitution of imported commercial fertilizer. A preferable alternative would be to consider smaller hydroelectric development on tributary rivers while stablizing the mainstream fishery with a research and management program aimed at long-term sustainable yield. Implementation of an effective effort would reestablish these species as an important food resource for humans. Before embarking on the Mekong development plan, it would be prudent to learn the consequences of China's Gezhouba Project. in which three hydroelectric dams are being built across the Yangtse River, with construction begun in October 1980.

Tropical Evergreen Forest. Thirty-four of the 155 animals occur in this habitat, 18 of them exclusively there. Well more than half of this habitat in Thailand has been deforested, and the economic incentive for conversion to rubber plantation is growing because of the rising cost of petroleum.

Hill Evergreen Forest. This habitat is required by 8 of the 155 animal species given status designations by this study, and it is used along with lower elevation forests by at least 24 others. This highland type has the smallest area of the three evergreen forest types, and it is under increasing deforestation pressure from mountain-dwelling people. As practiced by high-density human populations, shifting agriculture has become extractive. After the forest is cut, the land is farmed for a few years until it is too infertile for agriculture, and then it is burned annually to maintain *Imperata* grassland for low-density cattle grazing.

Dry Evergreen, Dry Dipterocarp and Mixed Deciduous-Evergreen Forest. Twenty-seven species occupy these xeric forests. Most prefer these habitats, but few are strictly limited to them. These forests once were widely distributed but now are mostly converted to agriculture, except for sizeable tracts remaining in northern and western Thailand.

Mangrove Forest. Six species occupy mangrove habitat but also occur elsewhere. Mangrove forest has been very heavily cut for charcoal, and it is doubtful if any primary mangrove forest exists in the country. To reverse the loss of this vegetation and stabilize use of this renewable resource, the Royal Forestry Department has begun to regulate mangrove harvest in units of 30 strips, with one cut per year in a 30-year rotational sequence. Effective enforcement of this regulation should provide both use of the wood on a sustainable basis and habitat for endangered and threatened species.

Coastal Rivers of Southeastern Thailand. Two species of fish from this region are listed. Their problem is presumed to be overharvest, not habitat loss, but more information would be useful.

Other Habitats. Sandy coastal beaches are nesting habitat for five species of sea turtles. Coastal mudflats are habitat for three species of birds, and coastal islands support three others. Sandy beaches of Songkhla Lake and river banks of the region are habitat for a turtle. Rugged limestone mountains are relictual habitat for many endemic species of plants but do not necessarily share a common habitat. The best known of these is Doi Chiang Dao, which supports at least 7 endemic species of plants.

EXAMPLE OF USE OF THIS REPORT PRIOR TO FIELD SURVEYS

Probable Occurrence of Endangered and Threatened Species in the Mae Chaem Watershed.

A cooperative land use development program between the Royal Thai Government and the United States Agency for International Development proposes to convert to permanent agricultural use land now under periodic slash-and-burn agriculture. The proposal is to establish and operate an agricultural research and extension service to introduce commerciable crops and improved farming techniques in the 300 km^2 watershed of the Mae Chaem, a tributary of the Mae Nam Ping in the western part of Changwat Chiang Mai.

Use of the overlays and maps in this report gives the following indication of what endangered species may be expected in the project area. The project area includes deciduous forest along the river and evergreen forest on the two flanking mountain ridges. As of 1972 the forest cover was nearly continuous, with little deforested area.

Plants:

Sapria himalayana
Aeginetia indica
Balanophora sp.
Buddleia macrostachys
Dendrobium scabrilingue
Lyonia ovalifolia var. *ovalifolia*
Phyllanthodendron mirabilis
Vanda coerulea

Amphibians and Reptiles:

Tylototriton verrocosus
Platysternon megacephalum
Pelochelys bibroni
Varanus bengalensis
Python molurus bivittatus

Birds:

Sarkidiornis melanotos
accipiters
Lophura nycthemera
Syrmaticus humiae
Polylectron bicalcaratum
Pavo muticus
Treron sphenura
Columba pulchricollis
parrots
owls
Ptilolaemus tickelli
Aceros nipalensis
Buceros bicornis
Mulleripicus pulverulentus
Drycopus javensis

Mammals:

Macaca nemestrina
Macaca arctoides
Presbytis phayrei
Hylobates lar
Manis pentadactyla
Petaurista elegans
Ratufa bicolor
Petinomys setosus
Eothenomys melanogaster
Canis aureus

Mammals cont'd.:

Cuon alpinus
Selenarctos thibetanus
Helarctos malayanus
Lutra lutra
Amblonyx cinerea
Prionodon pardicolor
Arctictus binturong
Felis marmorata
Felis viverrina
Felis bengalensis
Felis chaus
Felis temmincki
Neofelis nebulosa
Panthera pardus
Panthera tigris
Cervus eldi
Bos javanicus
Bos gaurus
Capricornis sumatraensis

ANALYSIS OF METHODOLOGY

To begin the project, a provisional list of endangered and threatened species of Thailand was compiled from lists of the following authorities: the United States Fish and Wildlife Service (1979), Convention on International Trade in Endangered Species of Wild Fauna and Flora (1979), Thailand's Wild Animals Reservation and Protection Act of 1961, the IUCN Red Data Books, and the IUCN report on Conservation for Thailand--Policy Guidelines (1979).

Information on listed species was gathered in three simultaneous phases--literature search, correspondence with IUCN experts, and in-country interviews and site visits. All three were judged to be basic and necessary, and all contributed substantially to the data from which the lists and species accounts were prepared.

Literature Search. Literature was sought using computer-based bibliographic services, by manual search for general and recent publications, and by library work in Thailand.

Computer literature searches were executed by staff of the University of Florida Libraries. Biosis Previews (incorporating Biological Abstracts and formerly, BioResearch Index), AGRICOLA (Agricultural On Line Access, incorporating mostly Bibliography of Agriculture, National Agricultural Library, U.S. Department of Agriculture), and CAB-ABS (Commonwealth Agricultural Bureau Abstracts) were found to be the most useful. For reasons of cost-effectiveness the searches were limited to species names and to the English language literature. When these searches were not

fruitful, the search was expanded to include genera (except in the cases of some wide-ranging genera) and all languages. Certain key word couplets, such as "endangered species-Thailand," were also submitted for search. The literature in the tape files of these information services generally only dates back to the late 1960's at the present time. A minor, but frustrating problem encountered was the incorrect spelling of scientific names in the reports from which the early species lists were developed. This was primarily due to poor editing of the reports, but also to the vagaries of biological systematics--some researchers insist one spelling is correct while others use different spellings. This led to many unsuccessful searches and the loss of valuable time. Computer requests were initiated by remote terminal from Gainesville, Florida, over the telephone lines to the computer in southern California. The printouts were sent to Florida by first class mail. Turnaround time was generally rapid--a week to ten days at the most. The printouts gave basic literature citations, showing the title, journal reference, author, and date. Sometimes key words, the authors' addresses, the language used, and other data were given. Computer literature searches were very efficient compared with manual work and therefore were an effective method for gathering information.

Manual literature searches were done to include literature too old or too recent to be in the computer files or in general works that do not have species names in the titles. Journals specializing in a particular taxonomic group, such as the Journal of Mammalogy and Ibis (birds), were examined, as were those dealing with a geographic region, such as Pacific

Science and the Journal of the Bombay Natural History Society. General works included various reports and symposium volumes published by IUCN (IUCN 1968, 1979, IUCN Red Data Books, for example), The Fresh-water Fishes of Siam, or Thailand (Smith 1945), The Fauna of British India series, Bird Guide of Thailand (Lekagul and Cronin 1974), Handbook of the Birds of India and Pakistan (Ali and Ripley 1968-1974), The Wild Mammals of Malaya (Medway 1969), and Primates of South Asia (Roonwal and Mohnot 1977).

Once a citation was identified as being relevant, several avenues were used to obtain a copy of the article. First, the libraries of the Florida State Museum, the University of Florida, and the personal files of local researchers were used. Then interlibrary loan requests were submitted through the loan office at the University of Florida library. The loan office eventually was able to find almost every article that was requested, including some very old or esoteric ones, but the turnaround time was typically a month or more. In some cases reprints were requested directly from the author. In a few exceptional cases, when an article was urgently needed and unavailable locally, researchers telephoned friends of theirs in large cities in the United States, who kindly photocopied and mailed the needed documents.

Library work was done in Thailand to obtain literature that was not readily available otherwise. The libraries of the Royal Forestry Department, the National Inland Fisheries Institute, the Thailand Institute for Scientific and Technological Research, the Siam Society, and the personal library of Boonsong Lekagul were notably useful. One new general work was discovered by visiting bookstores in Bangkok. Additional

literature thus gathered in Thailand included regional journals--specifically the Natural History Bulletin of the Siam Society and Malayan Nature Journal--and general works including Mammals of Thailand (Lekagul and McNeely 1977), The Orchids of Thailand (Seidenfaden and Smitinand 1959-65), and The Turtles of Thailand (Wirot 1979), plus numerous individual monographs and articles.

Correspondence with IUCN experts. At the beginning of the project, correspondence was begun with scientists of the IUCN's Survival Service Commission, which has 31 of 53 Specialist Groups that are relevant to endangered and threatened species of Thailand. This phase of the project, including later opportunities for making new contacts, was directed by Dr. F. Wayne King, Deputy Chairman of the SSC. Experts in the Specialist Groups provided reprints, unpublished reports, evaluations of status based on their extensive experience, and information providing access to new work being done in their areas of specialty. This information included many state-of-knowledge reports and led to wider follow-up correspondence through the duration of the project.

Interviews and Site Visits in Thailand. Prior to travel to Thailand, correspondence was sent to biologists in Thailand to introduce the project, request information, and ask whether any meetings or conferences on wildlife-related issues were scheduled there. This served as an introduction and gave government agencies an opportunity to delegate responsibility for interviews to the most appropriate people. The beginning of the interview trip coincided with a national workshop on wildlife management in national parks. Meeting most natural resource officials, university

biologists, and private conservationists there facilitated subsequent individual meetings both socially and logistically.

Interviews were conducted with government agencies, including their subdivisions, branches on university campuses, and several regional research stations; with university researchers; and with members of the private conservation community. These visits were requests for published and unpublished data on the biology of listed species. The list was discussed also in terms of status, possible delistings, and candidates for listing. In association with interviews, opportunities were taken to use institutional and personal libraries.

Travel was done as a second priority to visit first-hand some examples of ecosystems, parks, and management areas on which endangered species depend. Assistance with this travel was requested in advance by correspondence with several government agencies and the private conservation community, so several counterparts were available to arrange brief trips on short notice.

Refinement of List. The list was refined as several steps occurred. These included publication of a new list by the USFWS, procurement of the new list of species protected under WARPA (1972), and acquiring information on protection provided by the Thai Fisheries Act of 1947. Many additions were made to the list based on information developed through IUCN SSC correspondence and first-hand experience and discussion with experts in Thailand. Finally, a status designation was determined by careful evaluation of all information gathered in this study and noted on the final list as This Study (1980).

Difficulties encountered. The three difficulties that were anticipated at the outset of the project were adequately surmounted by the methods applied. These were the dispersed nature of information in the array of published literature, in the files of numerous experts, and in the files of Royal Thai Government agencies. The information available was procured and incorporated into this report.

Unanticipated difficulties involved conceptual approach and large information gaps.

The original conceptual approach of this project was unrealistic in one respect. It was our intention to emphasize planned development projects in gathering and presenting information on endangered species. This approach was judged ineffective for several reasons. A project-specific planning document soon loses its currency as old projects are completed and new ones are proposed. A report on endangered species of the only identified USAID land use modification proposal--in the Mae Chaem watershed--would not have provided the general planning tool desired. This problem was solved by postponing the project-oriented approach as the appropriate second step, in favor of first developing a general, nation-level overview of endangered species, with information on proposed project sites accessible through overlay maps.

Another problem was an information gap represented by the difference between the legal and authoritative lists of endangered and threatened species and the actual situation. To know if species occurring in a local area are actually endangered requires a national/international view

and cannot be determined from local data alone. This problem was partially solved by preparing the species accounts from all available information and exercising independent, professional judgment of status designations. The result is an expanded list offered by this study as the most realistic list available of endangered and threatened species of Thailand. However, a substantial information gap remains. Literally thousands of species of plants and animals may be threatened by nationwide deforestation, but not enough information exists to assess the status of these species.

The second large information gap was a lack of data on the distribution of major habitats of Thailand. This information is very useful in anticipating the kinds of endangered species impacts likely to be encountered in a project area. A partial solution was achieved by procuring maps of vegetation and deforested areas from the Royal Thai Survey Department and Royal Forestry Department and modifying them to prepare Figs. 1-8.

Optimal procedures and new approaches. No substitutions for the procedures used in this project are recommended. The basic optimal procedures are literature search, use of the IUCN/SSC network of experts, and in-country interviews and site visits.

We recommend against expensive preparation of data on groups of species listed under CITES; often these reflect a problem of indiscriminate trade, in which many of the included species are not endangered, threatened, or rare. Instead we recommend that the CITES list be used to consider individual species for listing as dictated by substantive data.

Development of a useful planning document depends heavily on the ability to map the distributions of listed species. Because the countless years of field and museum work are unlikely to have been done in most countries, these distributions can only be inferred from knowledge of the distribution of habitats. This was possible for the Thailand profile because pre-existing vegetation maps were available at nominal cost to the project. For profiles in countries having no generalized vegetation map, preparation of a map should be the first step, preferably as a subcontract to the overall project.

Also important in preparation of range maps is the availability of a current or recent map of deforested areas. This allows elimination from consideration of land that can no longer be occupied by forest animals. Again, a recent map was available for the Thailand profile. If one is unavailable, it can be prepared from satellite imagery. For a country the size of Thailand, a crude map can be prepared without computer enhancement for about $300 (black and white) or $500 (false color) plus staff time, with color images providing much more information. Extensive areas of tree plantations (commercial forestry, rubber, orchards) cannot be distinguished from natural forest without computer enhancement costing thousand of dollars.

If a vegetation map has to be prepared as part of profile development, the optimal addition of mapping Holdridge life zones (Holdridge 1967, Holdridge et al. 1971) could be done at modest extra cost. Two test sites in Thailand have had their life zones defined (Holdridge et al. 1971). Rather than reflecting numerous plant associations that may be determined by local conditions, Holdridge life zones are broad regional units defined by

the physical variables of elevation, temperature, and rainfall. These zones are definable on a world-wide basis and hence are recognizable to any ecologist. Many species of animals that are not confined to single habitats are restricted to one life zone, so a Holdridge life zone map is helpful in illustrating animal distributions.

SPECIES ACCOUNTS

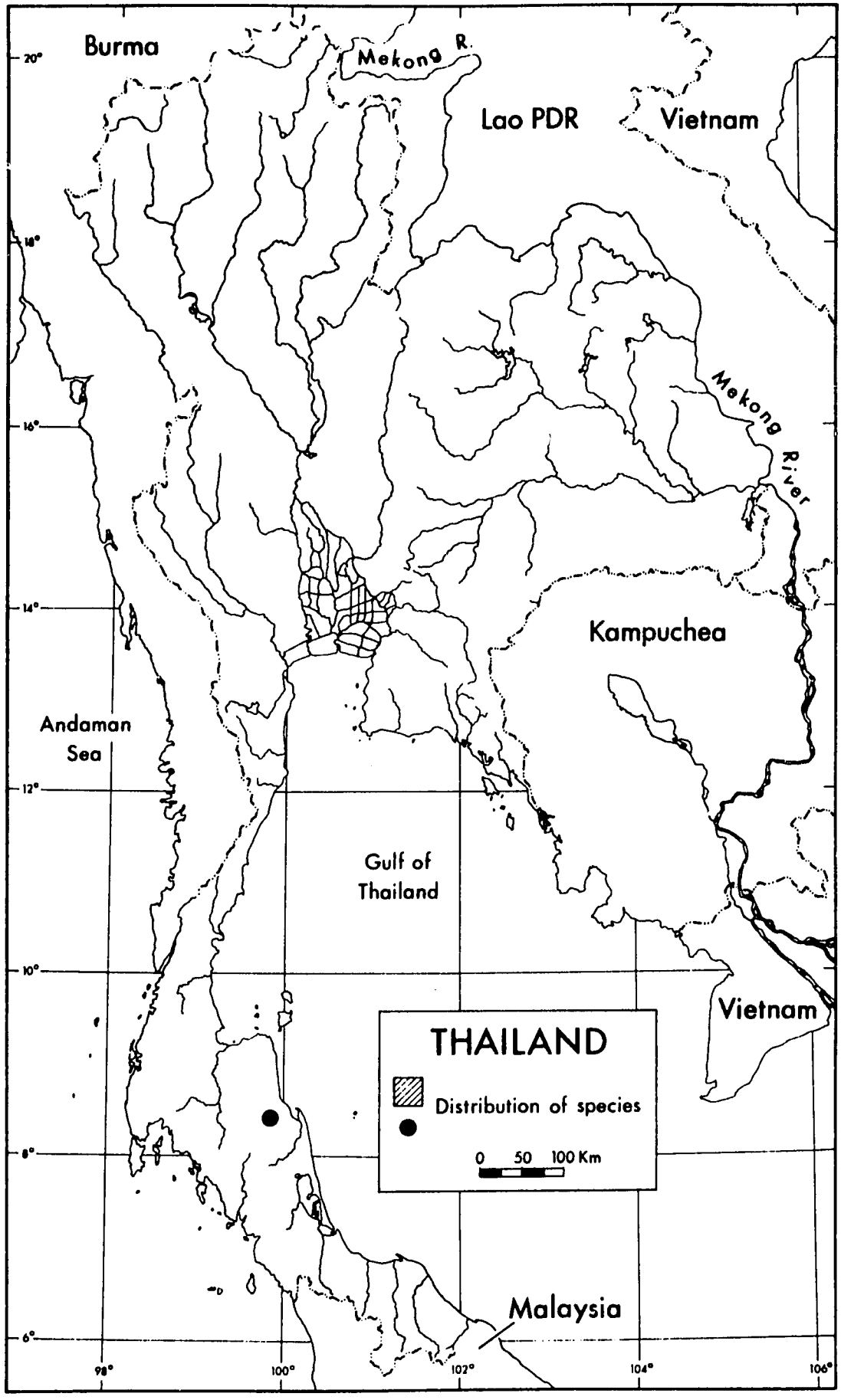
The accounts that follow are organized in phylogenetic sequence from plants, through invertebrates, fishes, amphibians, reptiles, and birds to the mammals. Most stand alone, but in a few groups, such as the sea turtles and hornbills, the nature of the data made it desirable to include a section of introductory comments, followed by species accounts and a common bibliography.

The technical data are organized into accounts of the status, biology, and management needs of the listed species. Each account is organized into data categories, in two groups. The first group is the more useful one for land use planners, for it permits evaluation of distribution and status, with the following categories of data: status, population size and trend, distribution and history of distribution, geographic status (peripheral, endemic, migratory, vagrant, etc.), habitat requirements and habitat trend, and vulnerability of species and habitat. The second group provides details on the biology of the species, for use by managers to solve conservation problems and by planners to suggest ways to avoid or mitigate undesirable impacts of development projects. Data categories in this group are causes of threat, responses to habitat modification, demographic characteristics, key behaviors, conservation measures taken, and conservation measures proposed.

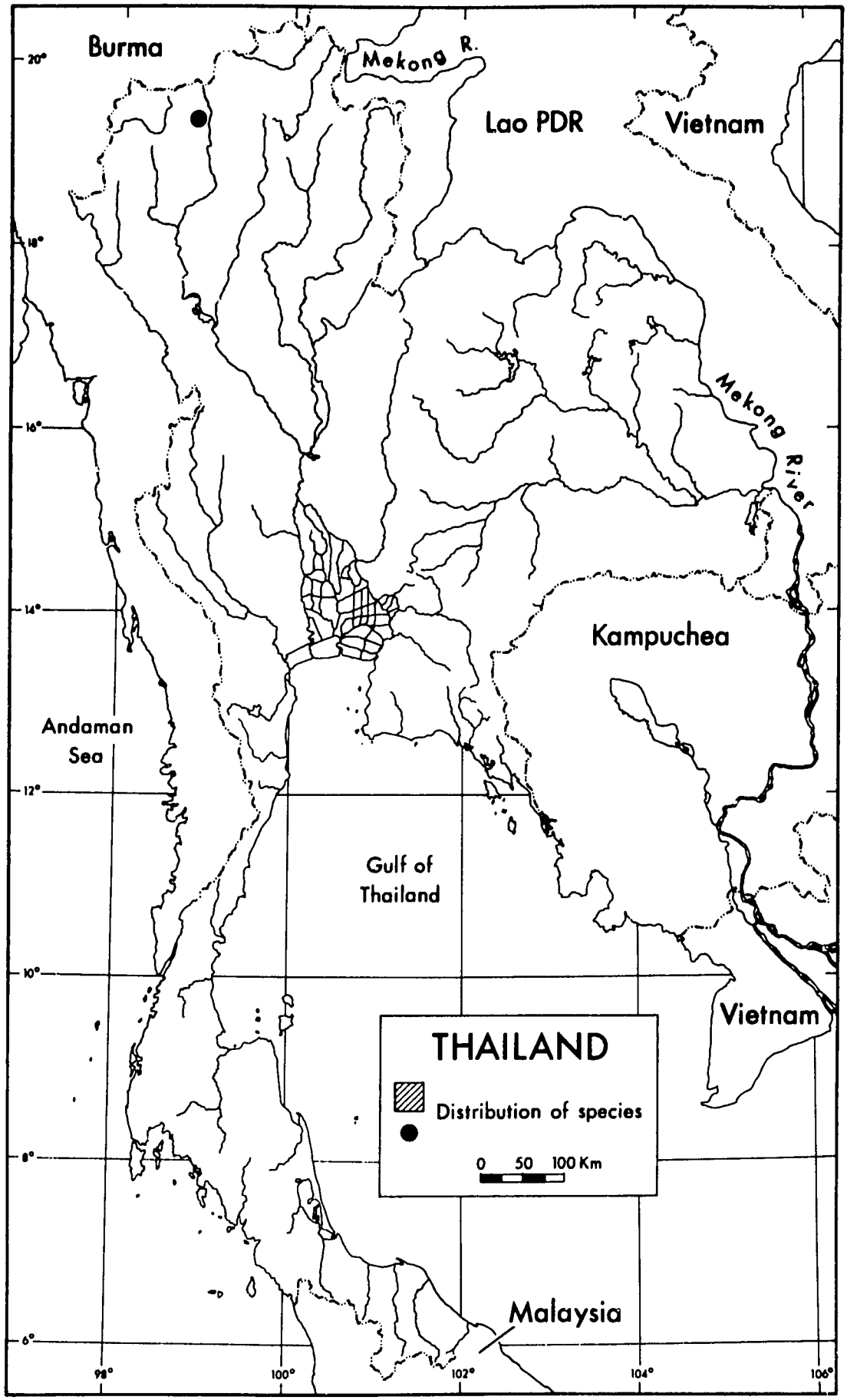
Another reason for organizing the data in these categories is to make possible in the future an analysis of the Thailand data using a new method of determining priorities for research and management of endangered

species. This priority system was developed by the Florida Game and Fresh Water Fish Commission and is being tested with the support of the U.S. Fish and Wildlife Service.

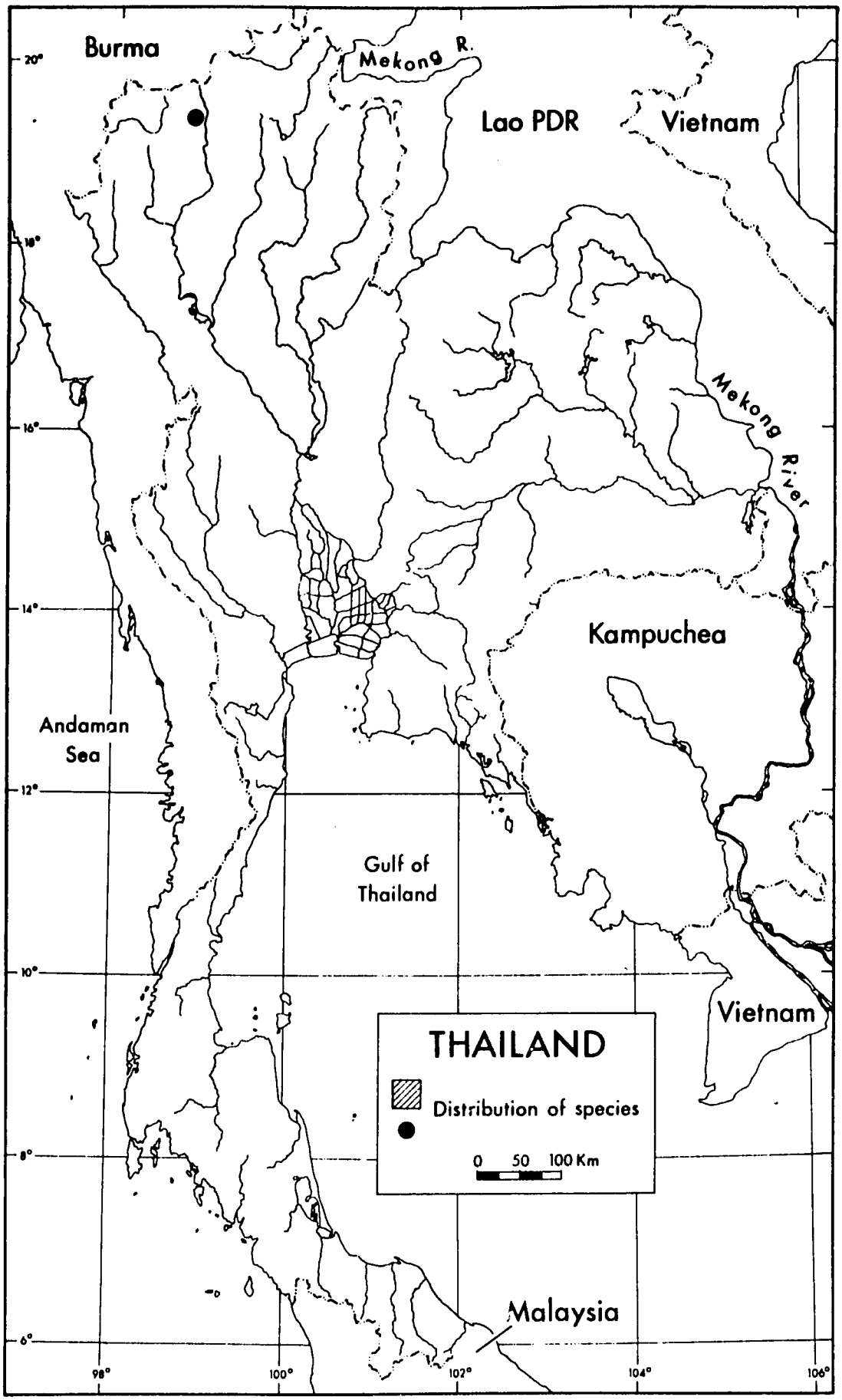
Maps accompany the species accounts for which sufficient distribution or habitat data exist. Maps prepared with dots represent actual documented distributions. Those prepared with lines shading an area are not authoritative, for they represent the probable range of the species based on knowledge of habitat requirements or elevation limits. A few maps of this type are done with spots but have a legend indicating "maximum potential" range. Question marks (?) indicate possible or uncertain localities. Whenever data premitted, we chose to show probable rather than documented range, because maps of probable range provide the more realistic picture of what is possible or necessary in planning for endangered species conservation.



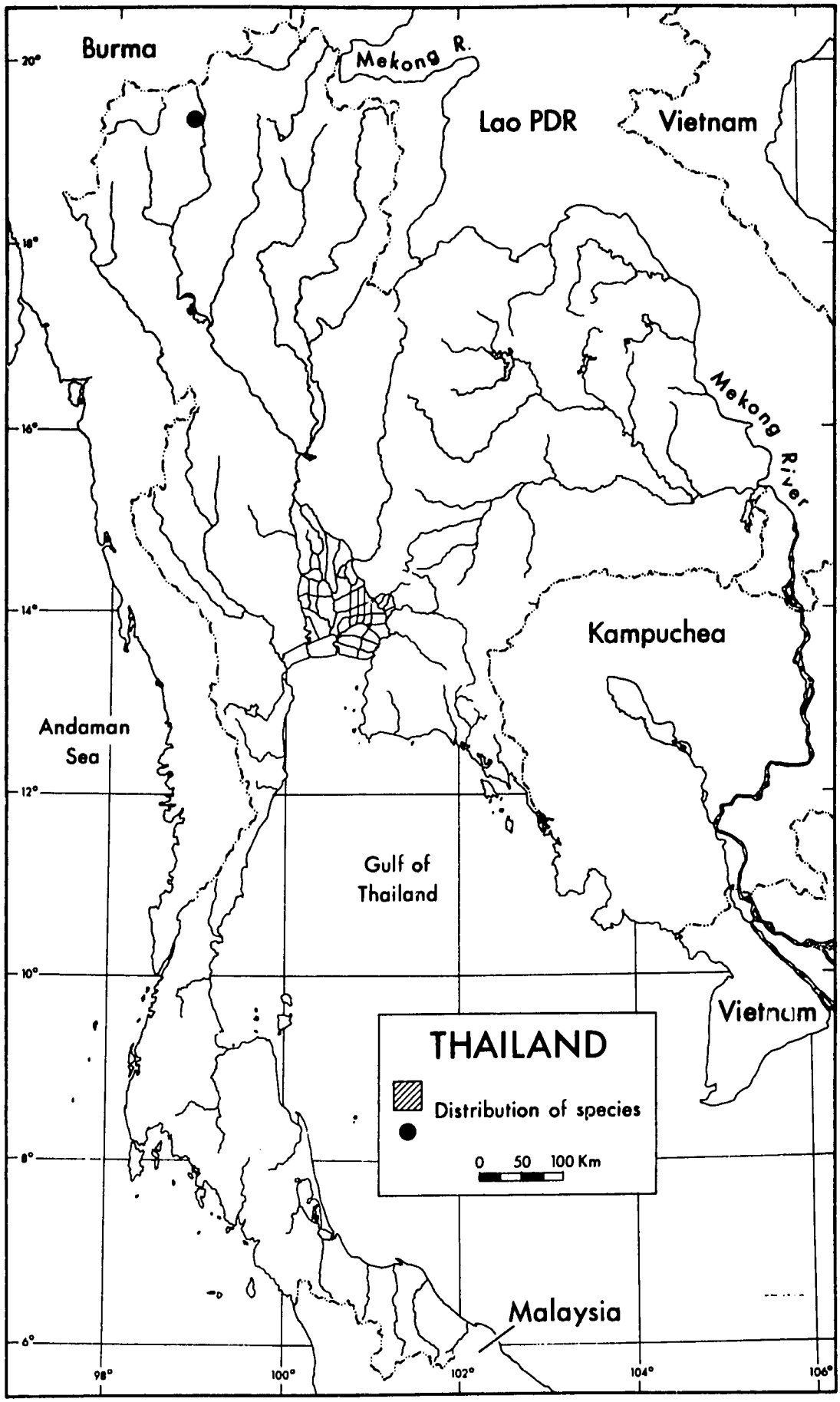
Balanophora laxiflora



Delphinium stapeliosum (D. altissimum)



Geranium siamense (G. lamberti)



Luculia gratissima

a new apocarpous fan palm

Maxburretia furtadoana Dransfield 1978

Angiospermae, Monocotyledoneae, Palmales, Palmae

Status: Threatened.
IUCN (1979): Rare, threatened.

Population Size and Trend: This palm is locally abundant at the type locality, unknown elsewhere. Population trend is unknown.

Distribution and History of Distribution: The species is known only from Khao Phra Rahu, elevation 300 m, and Khao Changai, two adjoining limestone hills near Surat in Chanwat Surat Thani (Dransfield 1978).

Geographical Status: This species is an endemic, confined to limestone hills. Evidently this is a relict of a former wide range.

Habitat Requirements and Habitat Trend: Habitat consists of the summits, ridges, exposed upper slopes, and crevices in precipices, of two adjacent karst limestone hills in peninsular Thailand. The habitat trend is unknown.

Vulnerability of Species and Habitat: Confinement to the limestone hills makes this species vulnerable to limestone quarrying operations and perhaps to uncontrolled fires from land-clearing activities at lower elevations.

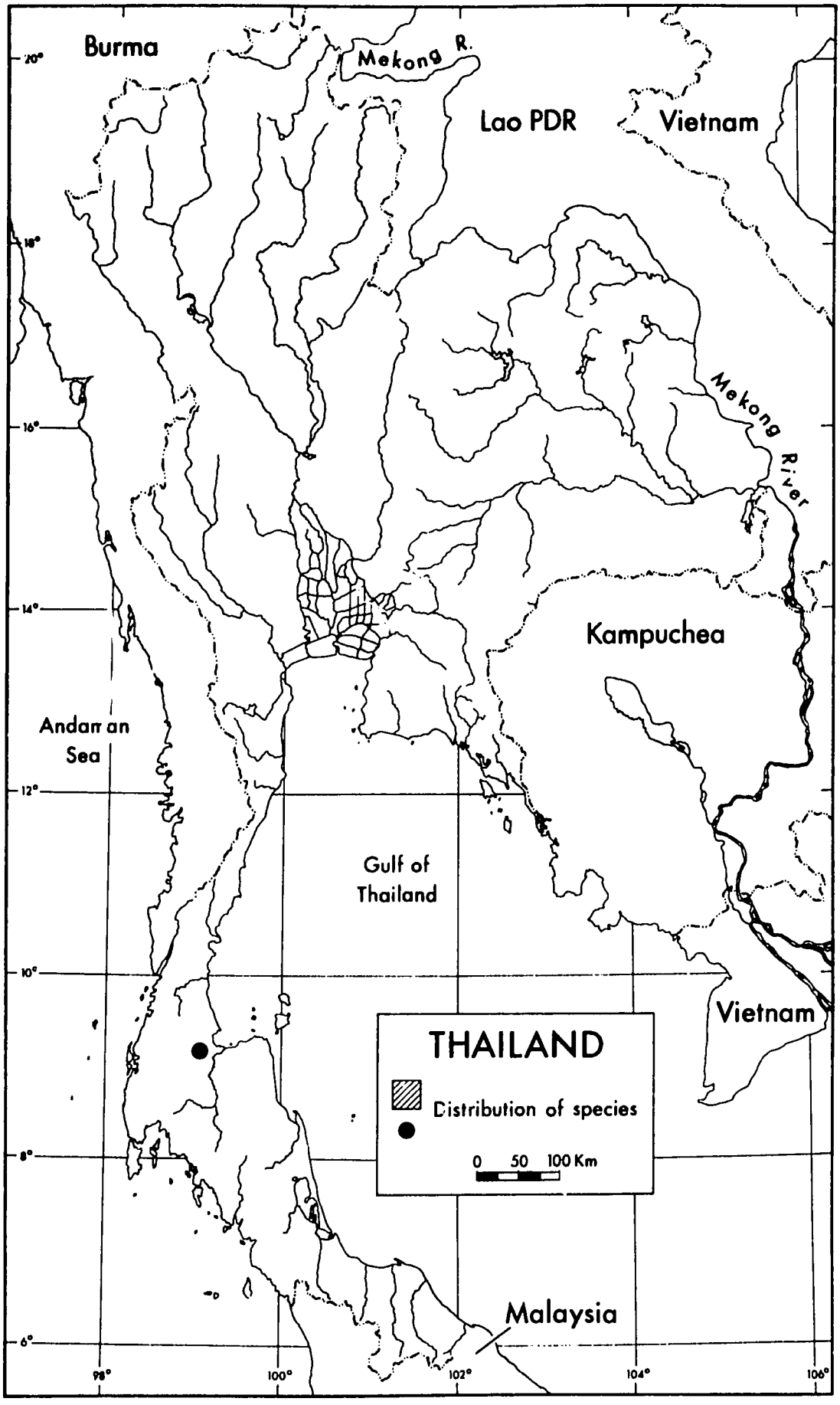
Causes of Threat: IUCN (1979) states that limestone quarrying operations pose a great threat to this species. Its Malayan congener, M. rupicola, is threatened by quarrying and by fires set by climbers (IUCN 1978).

Responses to Habitat Modification: Unknown.

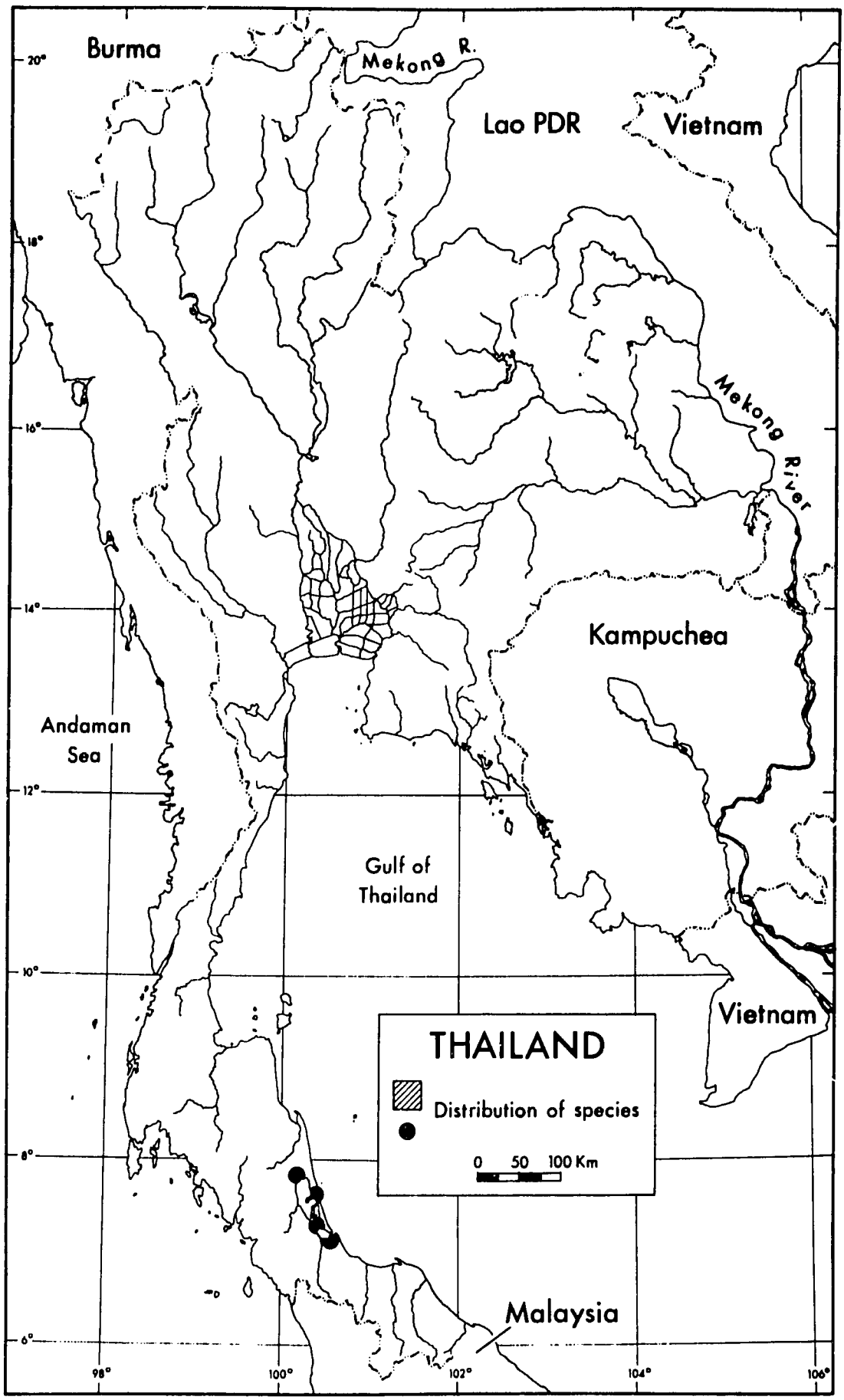
Demographic Characteristics: Unlike its two congeners, M. furtadoana is completely dioecious. Any attempt to cultivate this species would have to include individuals of both sexes.

Conservation Measures Taken: None.

Conservation Measures Proposed: A survey of suitable habitat in southern Thailand to identify any undiscovered populations of this palm would be timely. The known population should be protected from quarrying. Laws should be considered to regulate trade in this unique plant. The unusual, disjunct distribution, their many primitive features, and the unique floral morphology make the three *Maxburretia* of special interest to the student of plant geography and evolution (Uhl 1978, Dransfield 1978, Whitmore 1975).



Maxburretia furtadoana



Melaleuca cajuputi (M. leucodendron)

a parasitic phanerogam

Mitrastemma yamamotoi Makino 1909

Rafflesiaceae

Status: Threatened.
IUCN (1979): Threatened.

Population Size and Trend: Unknown. If it survives in Thailand its numbers are certainly small.

Distribution and History of Distribution: The species was collected only once in Thailand by Tem Smitinand in 1955 on Phu Kradeung, Tharn Sawan, Changwat Loei, at an elevation of 1300 m. This plant is also known from southern Japan, the Ryukus, Taiwan, Kampuchea, India (Assam), Sumatra, Borneo, and New Guinea (Hansen 1967, 1972; Lucas 1980, personal communication).

Geographical Status: Centrally located in the species' overall range. Populations are insular in nature because of restriction to montane habitats.

Habitat Requirements and Habitat Trend: This plant lacks chlorophyll altogether and is an obligate root parasite, probably on members of the Fagaceae (oaks, chestnuts, and their allies). In Thailand it was found in montane evergreen forest at 1300 m (Hansen 1967, 1972).

Vulnerability of Species and Habitat: Its complete dependence on trees makes M. yamamotoi vulnerable to deforestation.

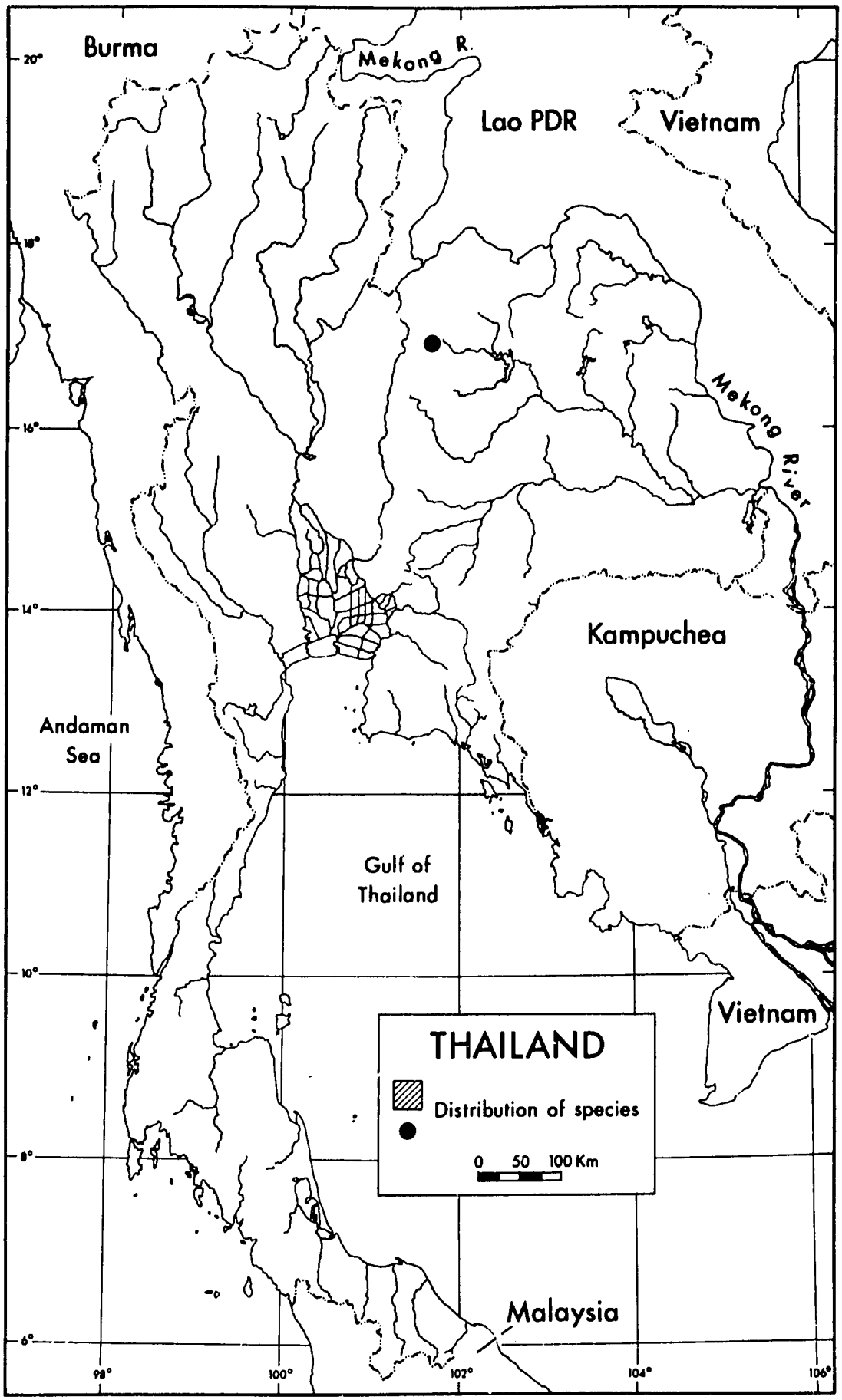
Causes of Threat: IUCN (1979) stated that forestry operations pose a great threat to this saprophyte.

Responses to Habitat Modification: Unknown.

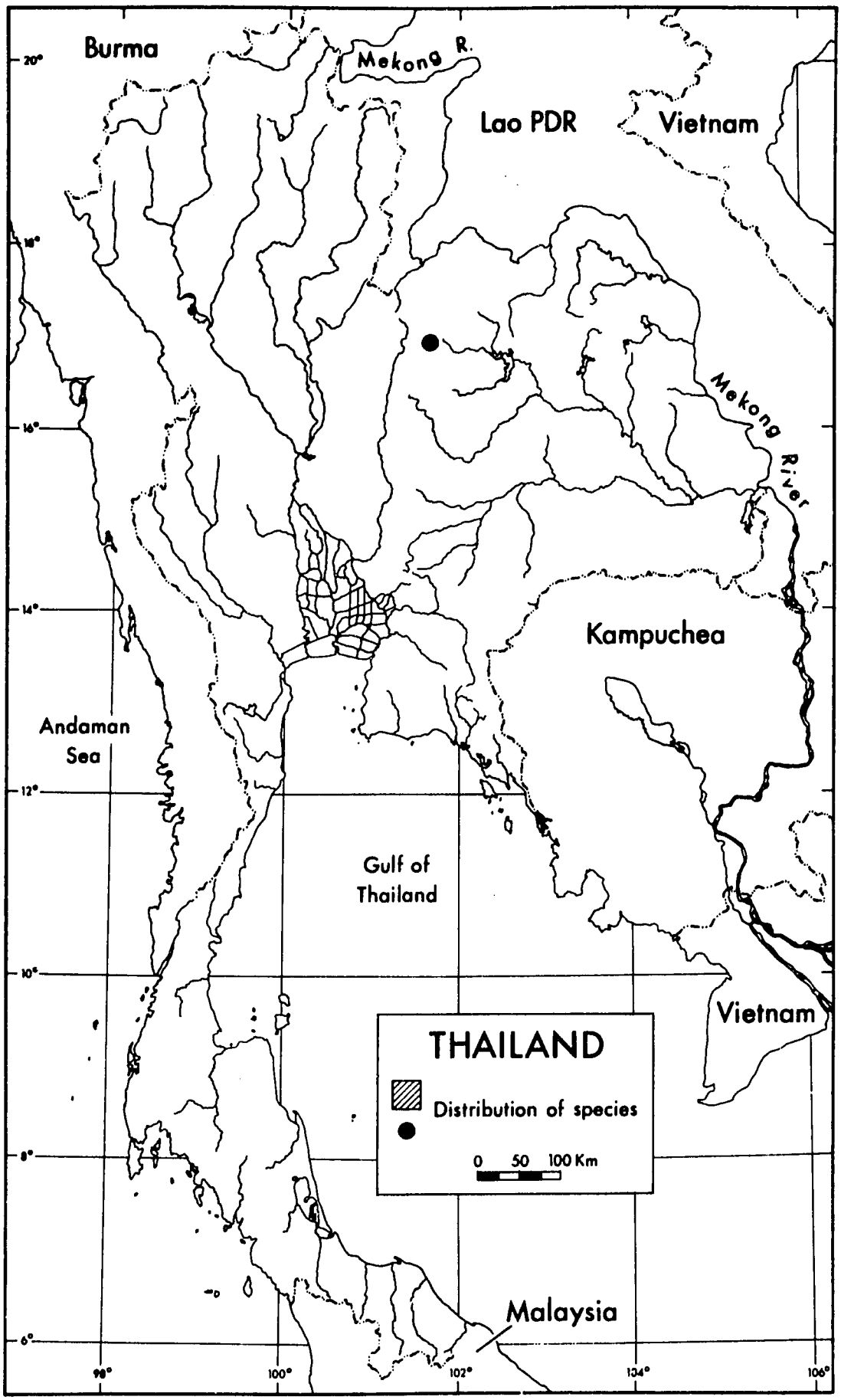
Demographic Characteristics: The bisexual flowers have numerous ovules and produce many small seeds. Individuals are perennial, flowering in October and November (Hansen 1972).

Conservation Measures Taken: Suitable habitat is included in Phu Kradeung National Park.

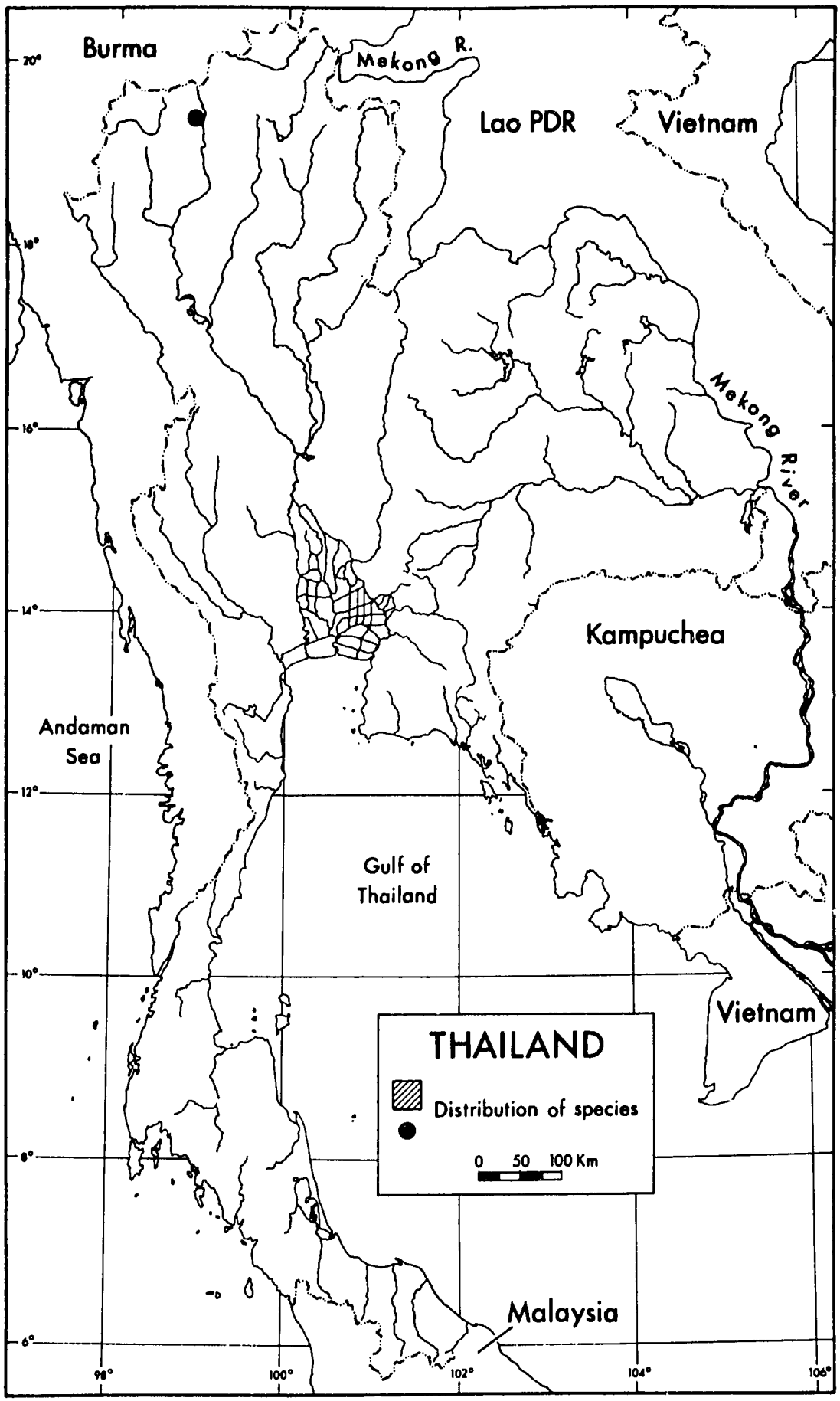
Conservation Measures Proposed: Montane evergreen forest should be surveyed to determine the distribution of the Thai population. Protection of this plant and its host species should be maintained in the Park.



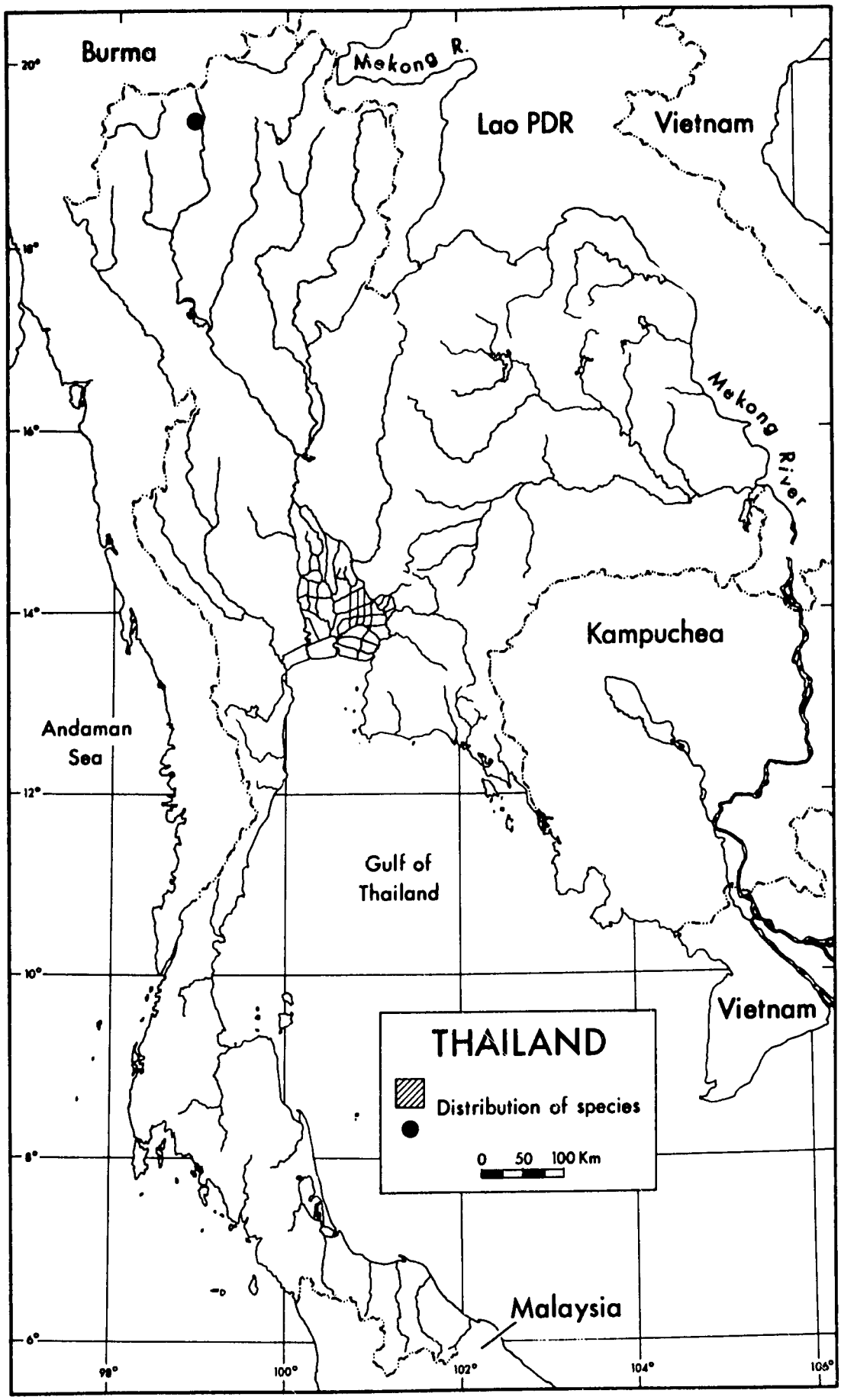
Mitrastemma yamamotoi



Pedicularis rhynchodonta



Pedicularis siamensis



Rhododendron ludwigianum

Krathon phrarusi, kathon rusi, a parasitic phanerogam

Sapria himalayana Griff. 1844

Rafflesiaceae

Status: Threatened.
IUCN (1979): Threatened.
IUCN (1968): Threatened.

Population Size and Trend: Unknown. S. himalayana is locally common in appropriate habitat if the host plants are present (Hansen 1972).

Distribution and History of Distribution: In Thailand it occurs on Doi Suthep and Doi Inthanon in Changwat Chiangmai and on Khao Pho Ta Chongdong (Khao Lanta Chong Dong) in Changwat Ranong. It is also known from India, Kampuchea, and Vietnam (Hansen 1967, 1972; Lucas 1980, personal communication; Robbins and Smitinand 1966).

Geographical Status: The Thai population is centrally located in the species' overall range. Populations are insular in nature because of restriction to montane habitats.

Habitat Requirements and Habitat Trend: This species completely lacks chlorophyll and is an obligate root parasite on a liana (khrua khao nam, Tetrastigma cruciatum Craib and Gagnep.) and sometimes on Illegera trifoliata Dunn. It is found in hill evergreen and lower montane forest in the ground layer, characterized by well developed humus and an adundance of rotting logs and leaf litter. Specimens have been noted from about 300 ft to over 5000 ft in elevation (Hansen 1967, 1972; IUCN 1968; Robbins and Smitinand 1966; Smitinand 1975).

Vulnerability of Species and Habitat: As an obligate parasite S. himalayana is vulnerable to human settlement, shifting agriculture, timber extraction, and other deforestation agents. Although it produces prodigious quantities of small, sticky seeds, its extreme host specificity makes it especially vulnerable to reduced host density. The principal host, T. cruciatum, is itself considered endangered by some authorities (IUCN 1968). Additionally, it makes "a striking splash of orange colour with its [large] yellow flecked starlike inflorescences" (Robbins and Smitinand 1966), attracting the attentions of plant collectors.

Causes of Threat: IUCN (1979) stated that forestry operations pose a great threat to this saprophyte.

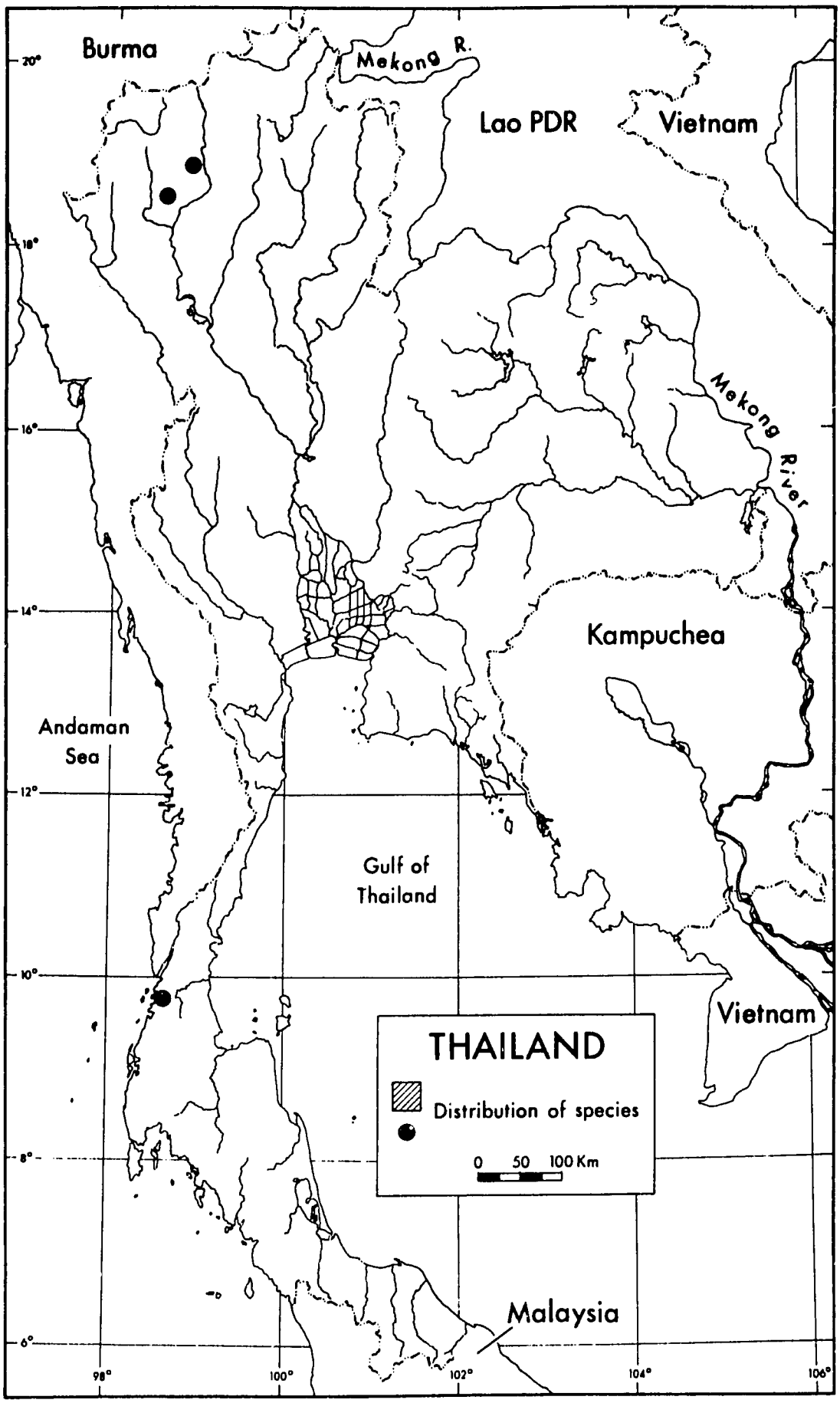
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The large, showy, solitary, unisexual inflorescences attract flies (Diptera) with an odor of rotten meat and trap them in the corona and widened portion of the column, probably effecting pollination. A multitude of sticky, minute, host specific seeds are produced. Flowering is from October to January (Hansen 1972; Smitinand 1975).

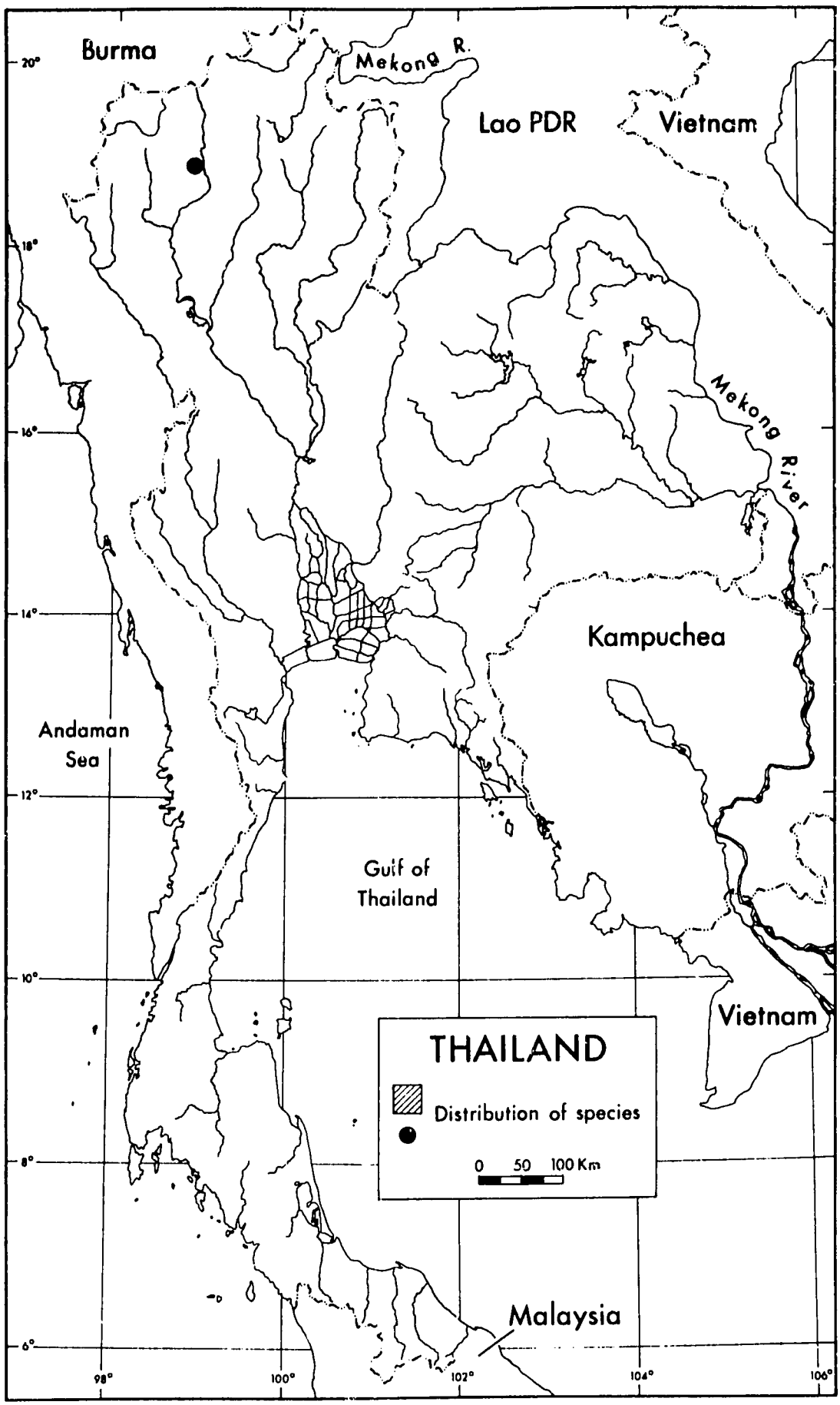
Conservation Measures Taken: The habitat of the Doi Inthanon population is included in Doi Inthanon National Park. The proposed Doi Suthep-Pui

National Park would protect the population on that mountain. The peninsular population in Changwat Ranong on Khao Pho Ta Chongdong is near the present border of Khlong Na Kha Wildlife Sanctuary, but is not included in it.

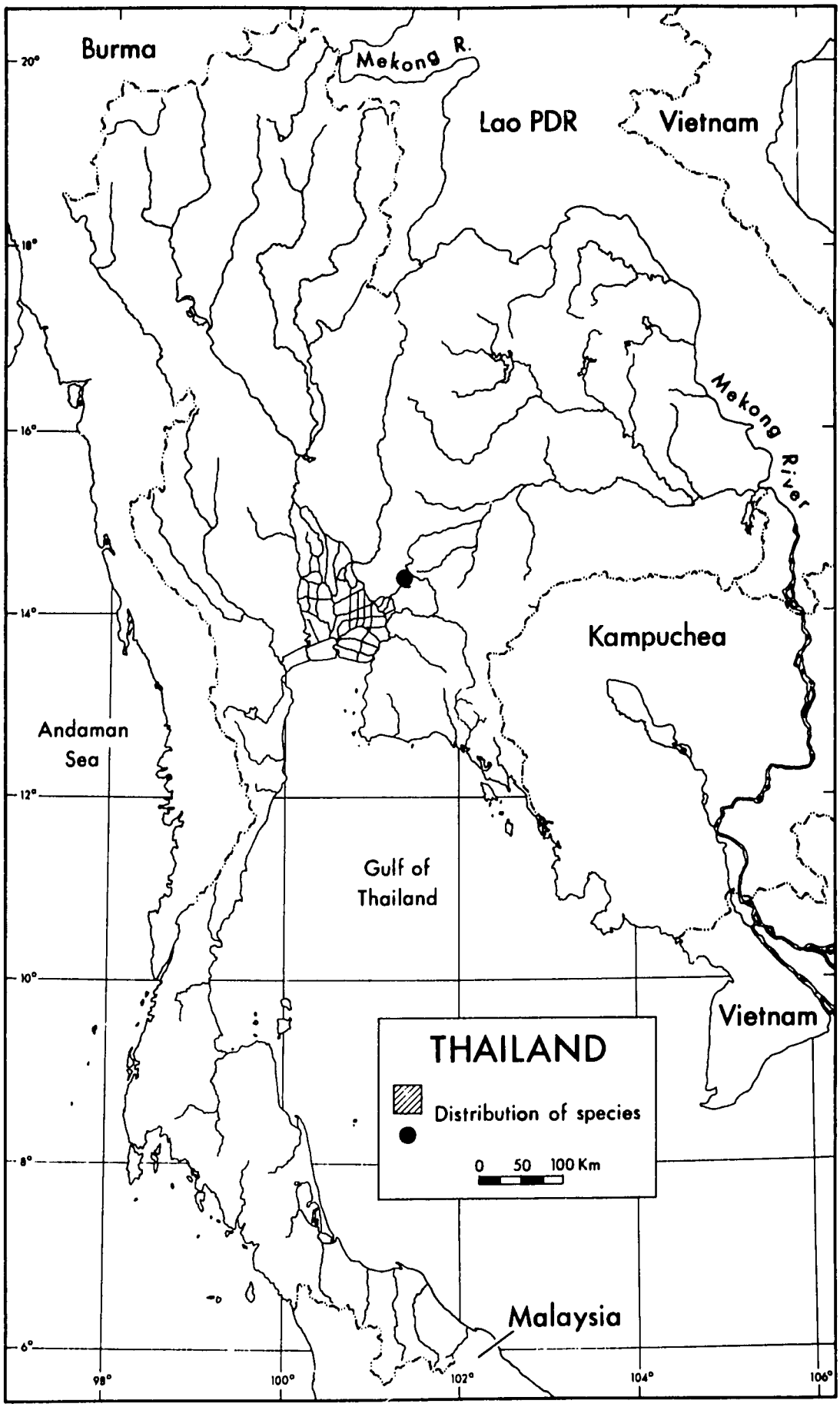
Conservation Measures Proposed: Basic survey work is needed to determine the true range of *S. himalayana* in Thailand. Protection of populations in National Parks should be emphasized and management plans for those areas should include considerations of the host plants. Collecting and trade of this *Sapria* should be monitored and controlled.



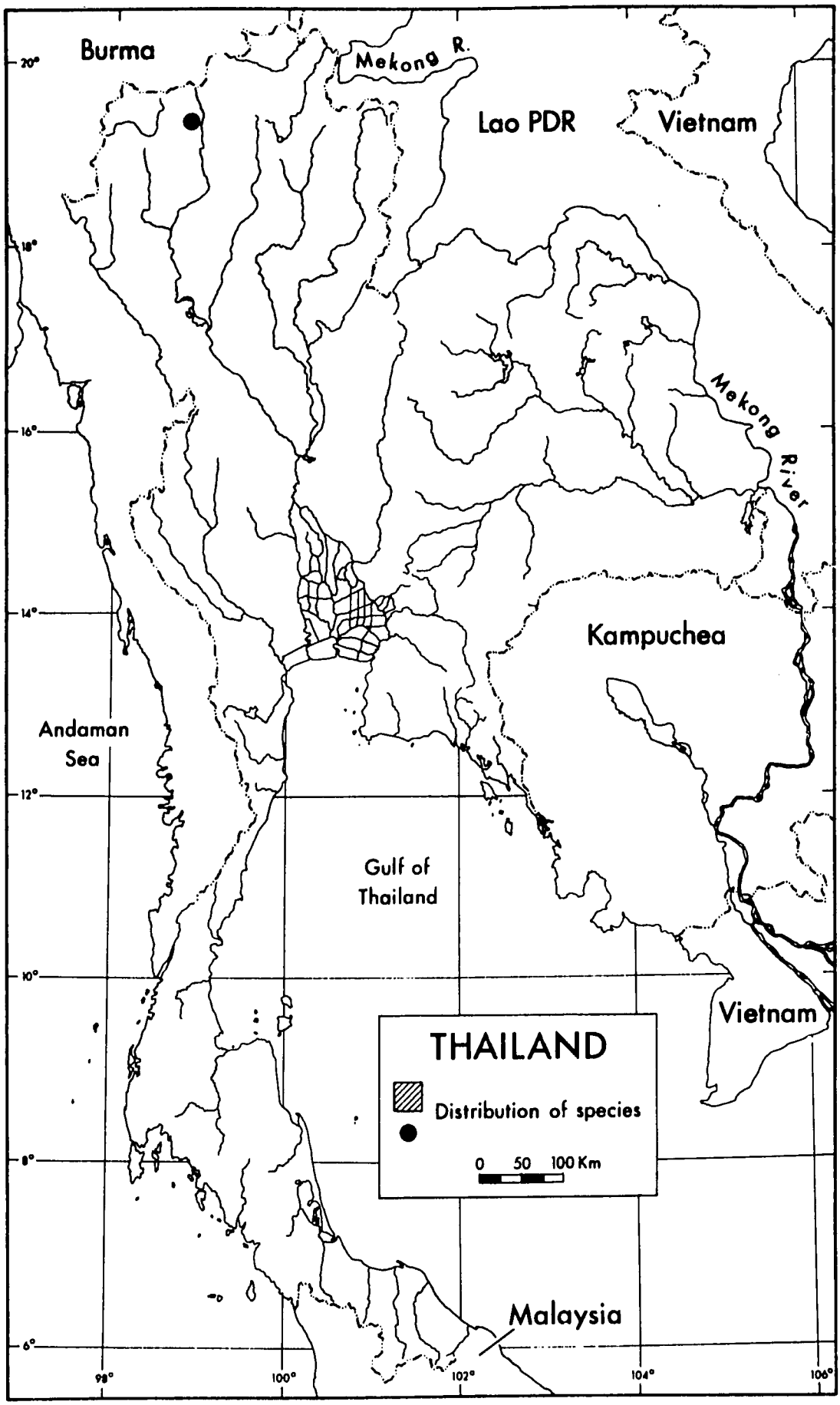
Sapria himalayana



Sciaphila thaidanica



Thismia mirabilis



Veratrum chiengdaoense

Jakajantalay, sea grasshopper, sand crab

Emerita emeritus (Linnaeus 1767)

Crustacea, Decapoda, Hippidae

Status: Threatened.

Population Size and Trend: E. emeritus was the most abundant of the anomuran sand crabs on the west coast of peninsular Thailand during an intensive survey from 1971 to 1973. The number of individuals per net haul (65 x 70 cm) per wave averaged from 0.1 to 8 over this geographical range (Boonruang and Phasuk 1975). However, by 1981 this species was virtually gone from the heavily harvested beaches of Phuket (Pensri Boonruang personal communication).

Distribution and History of Distribution: This species occurs on 9 discontinuous beaches in Changwats Phuket and Phangnga, on the west coast of peninsular Thailand. It is absent from similar sites along Changwats Ranong, Krabi, Trang, and Satun. E. emeritus (= E. asiatica H. Milne-Edwards) also is known from the east coast of India (Boonruang and Phasuk 1975).

Geographic Status: Thailand is on the eastern edge of the documented Indian Ocean range.

Habitat Requirements and Habitat Trend: E. emeritus are found between the low and high tide lines on sandy beaches. Several features of the physical environment have been quantified by Boonruang and Phasuk (1975), who considered the organic mud content of the substrate to be the most obvious physical limit to suitable habitat. No habitat loss has been documented, but pollution (such as organic sewage or nearshore seabed mining) could destroy required substrate qualities.

Vulnerability of Species and Habitat: Restriction of the species to a narrow zone of habitat at clearly defined sites makes it highly vulnerable to harvesting. The populations are isolated by segments of nonsuitable habitat, and the ability of individuals to move among suitable sites is unknown.

Causes of Threat: This species formerly was used as bait for surf-fishing. Since about 1965, a commercial market has developed both locally and in Bangkok (Boonruang and Phasuk 1975), and harvesting has intensified until the demise of populations occurred (Boonruang personal communication).

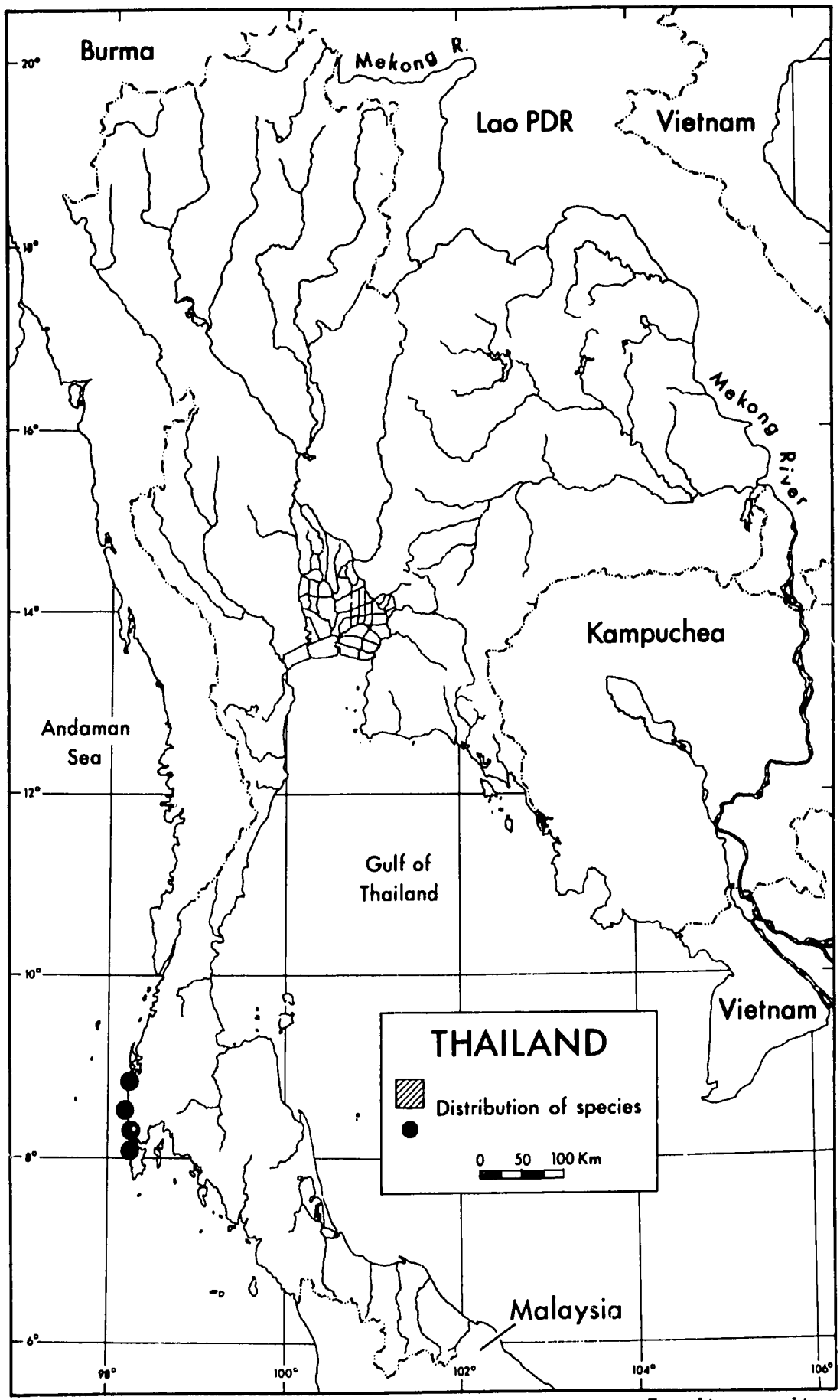
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Females in the size range of 20-29 mm carapace length bear eggs, numbering 500-6000 eggs per individual. Fecundity is directly proportional to body size, with eggs = 3505 (carapace length) - 3618. The population consists of a single year-class of males and 3 year-classes of females. The males and the youngest cohort of females arrive on the beach from December to April. The males and the two younger cohorts of females occupy the upper part of the beach, whereas the largest, egg-bearing cohort of females occupies the lower beach. Males mate with second year-class of females on the upper beach during the monsoon season (June to November), and the females move to the lower beach to form the large-sized cohort. This cohort of ovigerous females is most abundant in June and contains the most marketable individuals because of their size.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: Beaches where populations have been depleted should be closed to fishing for 4-5 years to allow a complete reproductive cycle to occur. Population monitoring in year 4 and later should be done to justify reopening the harvest at these beaches. Where populations are robust, sections of each beach should be closed to harvesting, with monitoring done to adjust the length of closed areas to a size that will sustain the harvestable populations at stable levels.



Emerita emeritus

Bhutan glory butterfly

Bhutanitis lidderdalei

Insecta, Lepidoptera, Papilionidae

Status: Threatened.

Population Size and Trend: Unknown.

Distribution and History of Distribution: The only reported locality in Thailand is Chiang Mai (Igarashi 1979). However, this must be an approximate designation, for Chiang Mai is well below the elevations at which the Bhutan glory is known to occur. The subspecies in Thailand has been reported variously as lidderdalei (Pinratana 1974) and ocellatomaculata (Igarashi 1979). The species ranges from Sikkim in China, the Naga Hills of Bhutan, India (Assam and Manipur), the Chin Hills of Burma (Ackery 1975), to northern Thailand.

Geographic Status: The Thailand population is a relict.

Habitat Requirements and Habitat Trend: Unknown in Thailand. B. lidderdalei occurs at elevations from 1550 to 2750 m in Bhutan and 2290 to 2750 m in Manipur; it flies weakly in the forest canopy and seldom is seen near the ground (Elwes 1891). Tytler (1912) found the species at 1675-2130 m from late August to early October in the Napa Hills. The larvae of the related species B. thaidina in southern China feeds on Aristolochia (Ackery 1975).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Hundreds of individuals are exported from Thailand annually to collectors (Jarujin Nabhitabhata personal communication). Deforestation also may be a threat.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: Entomologists at the Department of Agriculture and Thailand Institute of Scientific and Technological Research should undertake a search for this species in the montane forests of northern Thailand and work with Wildlife Conservation officials to develop a management plan. It may be possible to both conserve these butterflies and harvest them for commerce (Pyle and Hughes 1978).

Godfrey's junglequeen butterfly

Sticopthalma godfreyi Rothschild

Insecta, Lepidoptera, Satyridae

Status: Threatened.

Population Size and Trend: Unknown. Godfrey's junglequeen was considered rare (p. 82) or possibly extirpated (p. XIX) from Thailand (Lekagul et al. 1977). The species had not been seen since soon after its discovery in 1914 until a new population was found very recently (Samruadkit and Nabhitabhata, in preparation).

Distribution and History of Distribution: S. godfreyi ranges from the Dawna Range, Tavoy, and the Mergui Islands in southern Burma, western Thailand, to the upper part of peninsular Malaysia. In Thailand the species has been reported at Thong Pha Phum, Changwat Kanchanaburi, and Khlong Nakha Wildlife Sanctuary in Changwat Ranong (Samruadkit and Nabhitabhata, in preparation). It should be noted here that the Dawna Range in on the Thai-Burmese border.

Geographic Status: Thailand is central in the range of this species; however, populations appear isolated and may be relictual.

Habitat Requirements and Habitat Trend: Unknown.

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Populations may be naturally ephemeral, but any commercial or scientific collecting could be a significant threat.

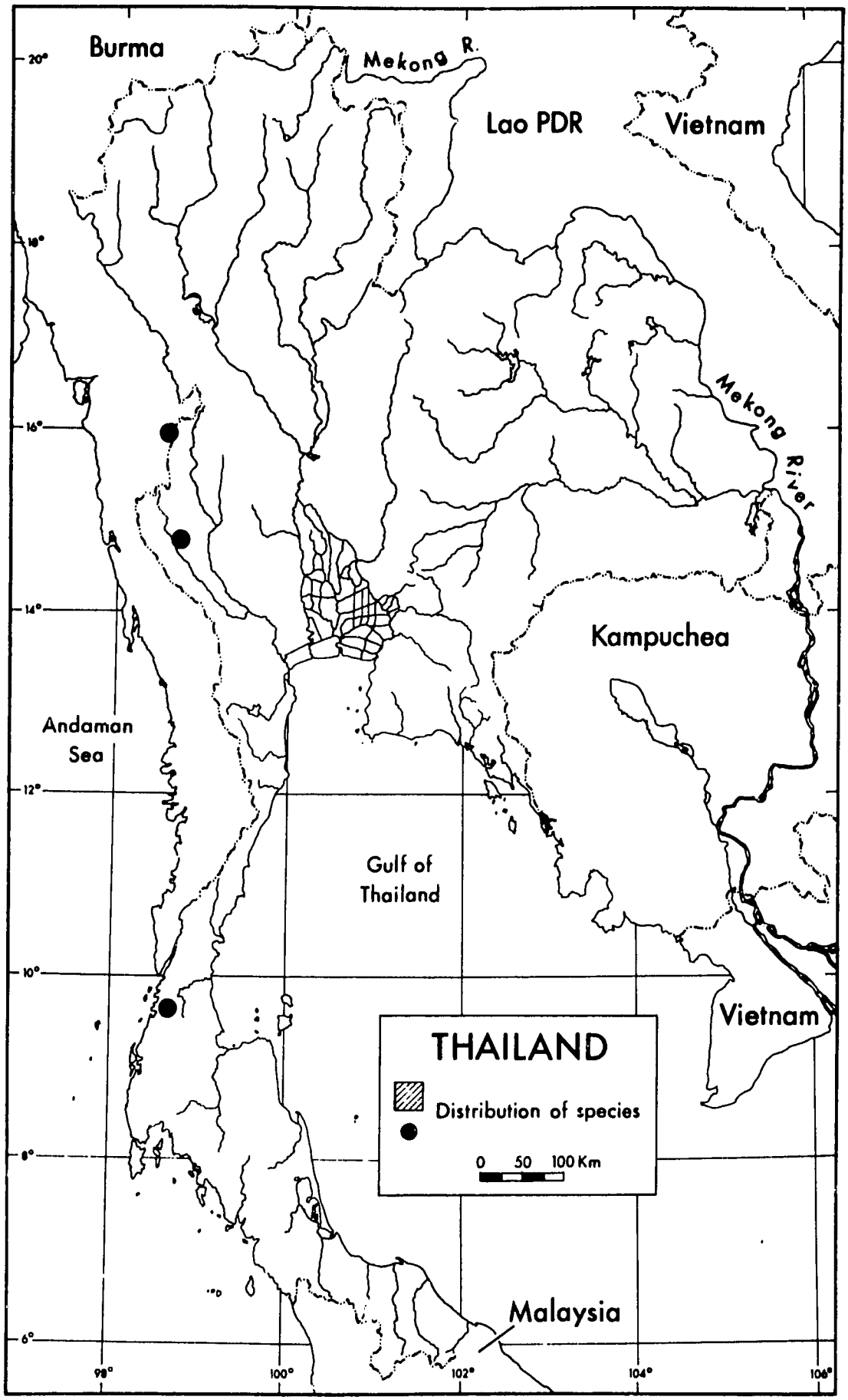
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: The species occurs in Khlong Nakha Wildlife Sanctuary.

Conservation Measures Proposed: Wildlife officials at Khlong Nakha Wildlife Sanctuary should take measures to protect the population there from butterfly collectors, because the market value of specimens is inversely porportional to their rarity. Field research is needed to determine habitat requirements and to learn what food plants could be promoted for managing this species. The successes of Papua New Guinea in protective law, management, butterfly farming for commerce, and promotion of butterfly-oriented park tourism (Pyle and Hughes 1978) show a number of ways that Thai butterflies could be conserved while being harvested for profit.



Stichopthalma godfreyi

Pla tapad, ikan kelasa, Asian bonytongue

Scleropages formosus (Müller and Schlegel 1844)

Osteichthyes, Osteoglossiformes, Osteoglossidae

Status: Probably extirpated.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN Red Data Book (1977): Vulnerable.
IUCN (1968): Threatened.

Population Size and Trend: S. formosus is now thought to be extirpated from Thailand (Sompote Ukkatawewat, personal communication). It used to be common in Thailand (Smith 1945), but the rangewide population of the species was given as fewer than 2000, based on a 1969 report (IUCN Red Data Book 1977). However, it was reported to remain common in Malaya in 1970 (Scott and Fuller 1976); in one swamp fishermen harvested 136 adults and 34 fry from July to October.

Distribution and History of Distribution: S. formosus is known from Vietnam, Kampuchea, Thailand, Malaya, Sumatra, the island of Bangka, Borneo, and the Phillipines (Smith 1945, Blanc and D'Aubenton 1965, Furtado and Scott 1971, Scott and Fuller 1976). No change in distribution is known other than apparent loss from Thai waters. Distribution includes the drainages of the Cardamon Mountains in Kampuchea and Thailand, with the Thai distribution confined to Changwat Trat and Chanthaburi (Ukkatawewat 1979). An unconfirmed report has been made of this species in the Khlong Pattani, Changwat Yala, Thailand (Sompote Ukkatawewat, personal communication).

Geographical Status: This specialized form of primitive fish has a relict distribution, restricted to oriental, tropical, fresh water.

Habitat Requirements and Habitat Trend: S. formosus occupies rivers, streams, canals, swamps, and reservoirs (Smith 1945, Smedley 1931, Furtado and Scott 1971). Details are known only for the swamp at Tasek Bera, Pahang, Malaysia. The Pandanus swamp is surrounded by a Eugenia swamp forest. The small areas of open water are shallow, up to 12 m deep in a few places; water level varies up to 6 m seasonally. The water is peat-stained, acidic (average pH of 6), and has a temperature range of 25-30° C (Scott and Fuller 1976). Here the food in March consists of surface insects and araneids. In October the food is mostly non-woody roots and tubers, along with a few insects and araneids (Furtado and Scott 1971). Fish, frogs, and snakes also are included in the diet (Ukkatawewat 1979). No habitat trend is documented.

Vulnerability of Species and Habitat: The species is an important and desirable source of human food and is vulnerable to overfishing. Excessive harvest can easily deplete the breeding stock because of reproductive adaptations. The swamp habitat in Malaya is condsidered to be threatened (Scott and Fuller 1976). Habitat in southeastern Thailand is being destroyed by dredging for rubies.

Causes of Threat: Decline and extirpation in Thailand apparently resulted from overharvest and river dredging.

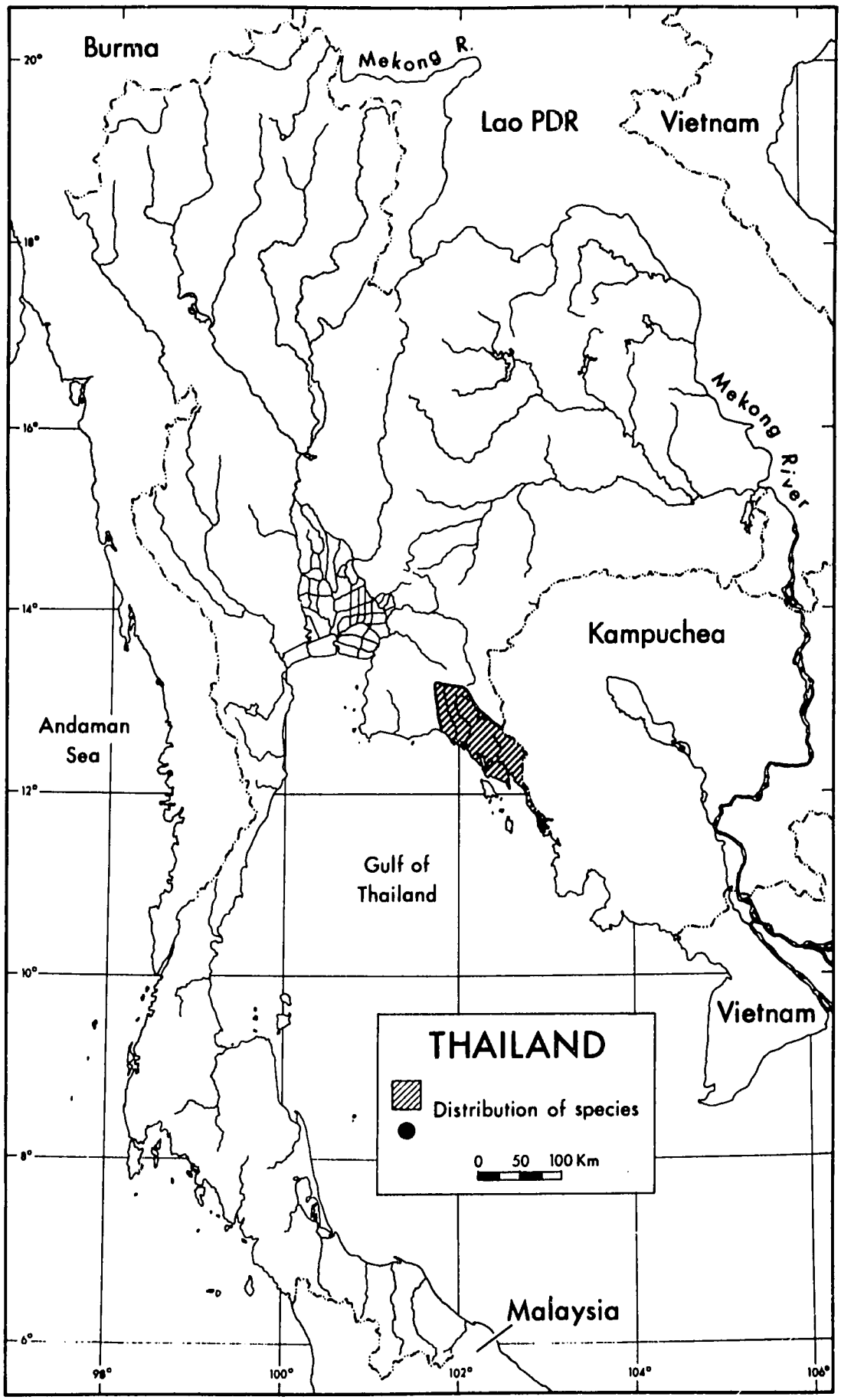
Responses to Habitat Modification: Unknown. Clearing of swamp forest fringing swamp habitat, by increasing nutrient flow into the swamp, could speed succession from swamp to more terrestrial habitat.

Demographic Characteristics: Reproduction of S. formosus is highly specialized, with late sexual maturity, low natality, and high survival of young, apparently in response to natural selection imposed by a diverse community of predators. Adults possess only one ovary or testis. Females produce a small number of large eggs, which measure 19 mm when mature in August to October (Scott and Fuller 1976), coinciding with a seasonal rise in water level. The number was 20 to 30 eggs in Malaya (Scott and Fuller 1976), with a case of 37 recorded in Thailand (Ukkatawewat 1979). After spawning, the male (contrary to earlier reports regarding females) incubates the eggs in his mouth until they hatch, and the fry remain near the parent until at least 80 mm long. Females are sexually mature when 3 years old; possibly the largest 2-year olds also spawn (Scott and Fuller 1976). These authors documented population structure of year classes from fry to 3-year olds and attributed the absence of older fish to possible emigration or heavy mortality, the latter possibly due to intensive fishing with poison 4 years before sampling. Distinct age structure indicates that spawning is highly seasonal. In Malaya, this fish reaches a maximum size of 7.4 kg in weight and about 1 m in length (Alfred 1964).

Key Behaviors: In swamps, the fish retire to Pandanus stands during daytime and move into open water at night to feed at the surface. Here they are vulnerable to spearfishing. The fish are territorial. At spawning time, S. formosus become difficult to catch, and fishermen seek them in lagoons fringed by Eugenia. This suggests that the fish may move toward the shallow swamp edge to spawn (Scott and Fuller 1976).

Conservation Measures Taken: An early attempt at commercial pond culture apparently was unsuccessful, presumably because of low fecundity (Furtado and Scott 1971). The Thai Inland Fisheries Division procured 37 eggs from one of the last S. formosus captured in southeastern Thailand and succeeded in rearing 4 animals to large size. These siblings are housed in the National Inland Fisheries Institute at Kasetsart University, Bangkok.

Conservation Measures Proposed: A survey of the range of *S. formosus* should be made to confirm that a costly reintroduction program is needed. The availability of Malayan populations and a small native stock make a captive breeding and/or reintroduction program possible, though rapid action will be necessary to the advantage of the latter. A captive breeding program may have to accommodate the species' territorial behavior and use of swamp forest in spawning. Attention should be given to genetic differences between native and non-native stocks. Reintroduction should be accompanied by a closed season and research to determine what harvest level later will be compatible with optimum sustained yield. Such a well-managed fishery cannot be attained until prohibitions against fishing with explosives and poisons (Alfred 1969, Anonymous 1976) are enforced.



Scleropages formosus

Pla tong lai, featherback

Notopterus blanci D'Aubenton 1965

Osteichthyes, Osteoglossiformes, Notopteridae

Status: Threatened.
IUCN (1979): Threatened.
IUCN Red Data Book (1977): Rare.

Population Size and Trend: Unknown. Apparently few now exist. When first described, N. blanci was found to be abundant in the Mekong (D'Aubenton 1965).

Distribution and History of Distribution: The featherback has been found in the Mekong River in Kampuchea upstream of Kratie and along the border of northeastern Thailand, and in the Mae Nam Mun (D'Aubenton 1965, Sontirat and Mongholprasit 1968, Rainboth et al. 1976).

Geographical Status: This is a freshwater, riverine fish. Congeneric species occur in rivers, canals, and swamps (Davidson 1975).

Habitat Requirements and Habitat Trends: Habitat is in the rocky zones of major rivers where the current is strong (D'Aubenton 1965) but was later reported as the backwaters and pools of large rivers (IUCN Red Data Book 1977). Trends are unknown, but major reduction of habitat may be expected to result from the several dams and navigation channels (Lagler 1976b) planned along the length of the Mekong.

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Reasons for the apparent rarity of N. blanci are unknown. Its meat is considered moderately good (Davidson 1975). Whether the planned reservoirs are a threat depends on whether the species can live in lentic habitat. Rocky shoalwater habitat is threatened by inundation and clearing for navigation.

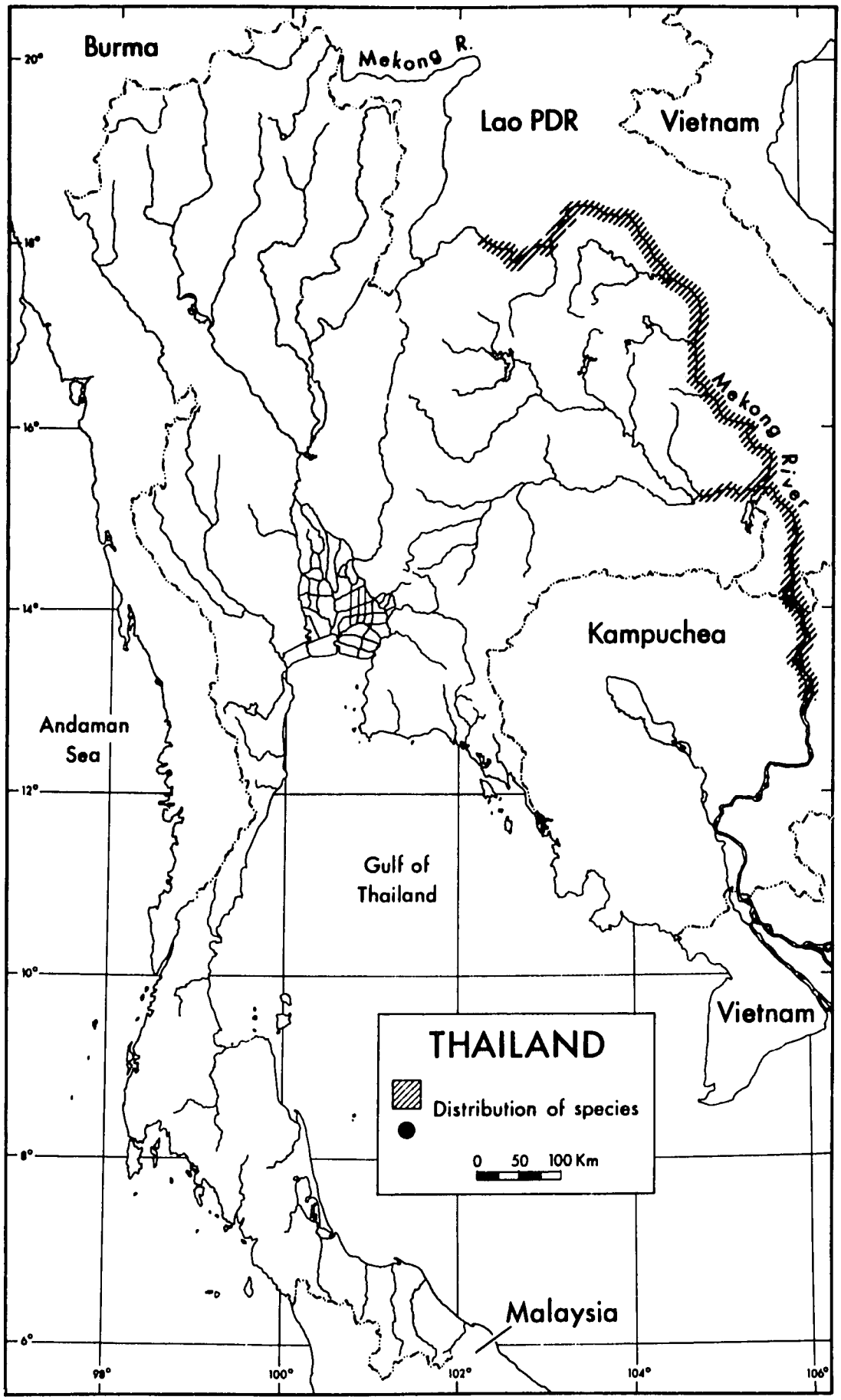
Responses to Habitat Modification: Unknown. The species was not recorded in surveys of Lam Dom Noi, Lam Pao, and Nam Pong reservoirs (Lagler 1976a). However, the rivers flooded by these reservoirs were not known to be occupied by N. blanci.

Demographic Characteristics: Unknown. In the congener N. chitala, breeding at Bung Boraphet occurs from February to August, when flooding begins. Several hundred to several thousand eggs are laid in a mass. Each female lays three batches of eggs per year at wide intervals. Incubation takes 5-6 days (Smith 1933).

Key Behaviors: Unknown. In the congener N. chitala, the parent fish clear a circular depression in the mud at the base of a stake or stump, and the eggs are attached to the wood above the mud. The male tends these, fanning them with his tail to keep them aerated and free of sediment, and guarding them against predatory catfish and minnows. Upon hatching, the fish drop into the depression and remain there until the yolk sac is absorbed. Then the young swim about and feed (Smith 1933).

Conservation Measures Taken: The Thai Inland Fisheries Division has captured 10-20 N. blanci in the Mekong. Two individuals are in an aquarium in the National Inland Fisheries Institute in Bangkok. Attempts to breed the animals at the fisheries research station in Nong Khai have been unsuccessful so far (Sompote Ukkatawewat, personal communication).

Conservation Measures Proposed: A status survey in the field would provide information on distribution, abundance, and habitat. Monitoring of harvest and documentation of size and age classes would begin the process of evaluating whether the harvest is sustainable. If parental care is as in N. chitala, fishing around egg-laying sites will remove the male and doom the eggs; reproduction should be favored by eliminating this practice. Smith (1933) reported methods for hatchery rearing of N. chitala.



Notopterus blanci

Pla satu, a featherback

Notopterus borneensis Bleeker 1851

Osteichthes, Osteoglossiformes, Notopteridae

Status: Endangered.

Population Size and Trend: Unknown. *N. borneensis* is apparently very rare in Thailand; attempts to collect them from fishermen have yielded 2 specimens (Ukkatawewat personal communication).

Distribution and History of Distribution: Records are known from the Mae Klong, Changwat Kanchanaburi (Ukkatawewat, personal communication), and the Suret River in Changwat Surat Thani (Sontirat et al. 1971). Elsewhere the species is known from Borneo and Sumatra (Smith 1945).

Geographical Status: Unknown.

Habitat Requirements and Habitat Trend: Unknown.

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Unknown.

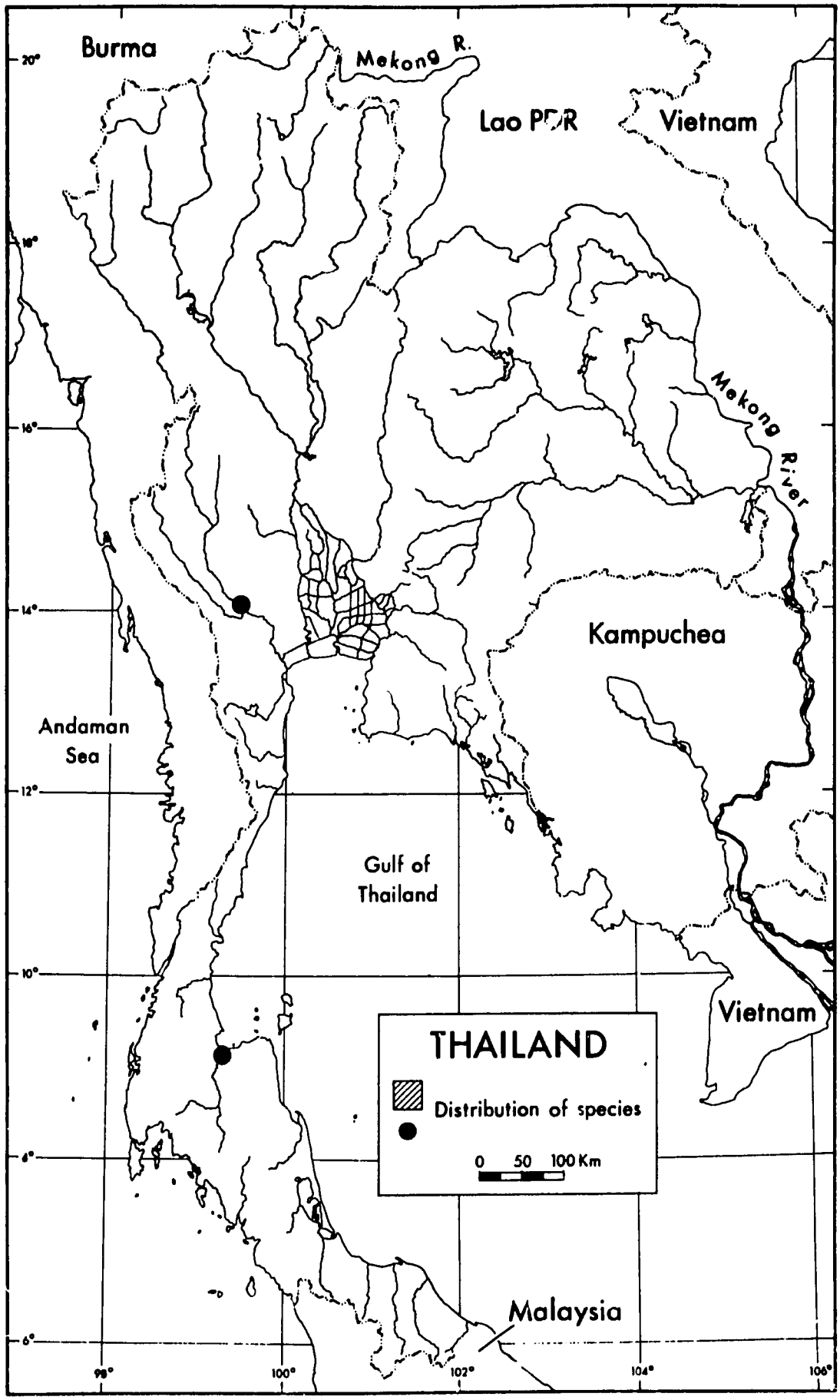
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: Information could be gathered by continued work in the field and correspondence with fish biologists elsewhere in the species' range.



Notopterus borneensis

Pla dab lao, pla tong plu, plá pak pra, a carp

Macrochirichthys macrochirus (Cuvier and Valenciennes 1844)

Osteichthyes, Cypriniformes, Cyprinidae

Status: Threatened.

Population Size and Trend: Population size is unknown. A decline is evident in the Mae Nam Chao Phraya; the species has not been reported there in the last decade but was abundant prior to 1960 (Suebsin Sontirat personal communication).

Distribution and History of Distribution: In Thailand M. macrochirus is known from the Mae Nam Chao Phraya, the "Tapi" River (Khlong Thepha?), Thale Sap, Thale Noi (Smith 1945), and the Mae Nam Mun (Suebsin Sontirat personal communication). Elsewhere it occurs in Kampuchea, Vietnam, Java, Sumatra, and Borneo (Smith 1945).

Geographical Status: Thailand is on the northeastern edge of the species' range.

Habitat Requirements and Habitat Trend: The species inhabits large rivers and lakes (Smith 1945).

Vulnerability of Species and Habitat: This is the largest local species of abramid carp, and it is highly sought as a game fish, by using a light rod (Smith 1945).

Causes of Threat: None are documented, but the population decline in the Chao Phraya may have resulted from excessive harvest.

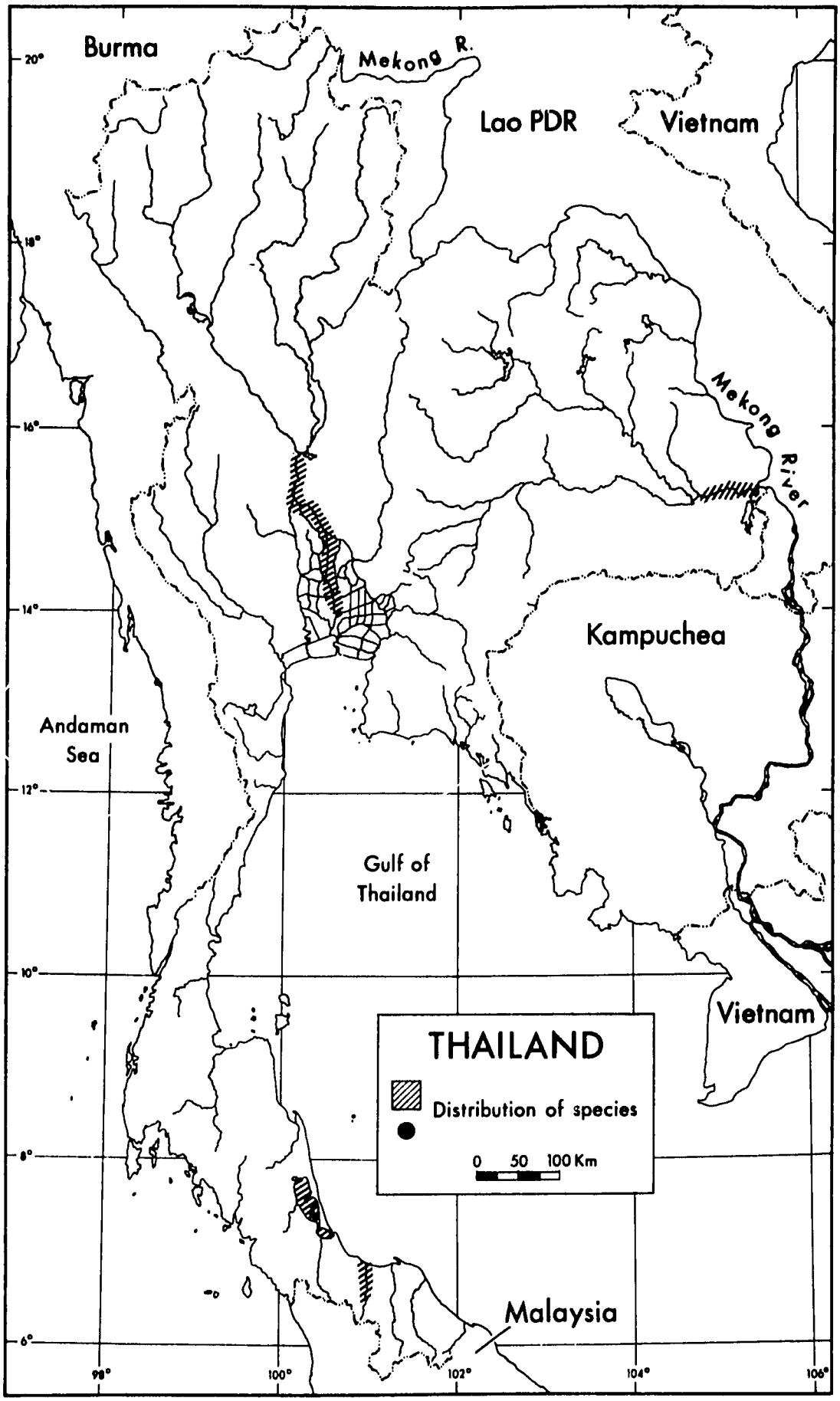
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown. The species reaches more than half a meter in length (Smith 1945).

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: A field survey of the status of *M. macrochirus* should be conducted to determine the nature of the problem and the need for corrective management.



Macrochirichthys macrochirus

(no common name)

Chela caeruleostigmata (Smith 1931)

Osteichthyes, Cypriniformes, Cyprinidae

Status: Threatened.
IUCN (1979): Threatened.
IUCN Red Data Book (1977): Rare.

Population Size and Trend: Population size is unknown but very small. No trend data are available, though a decline is apparent (IUCN 1977).

Distribution and History of Distribution: The range of this species in Thailand is restricted to the upper Mae Nam Chao Phraya, and all reported specimens are from 1923-25. Reported localities are a stream flowing out of Bung Boraphet near Paknampo, sites in the Mae Nam Chao Phraya below Nakhon Sawan and near Chainat (Smith 1931, 1945), and Khlong Nong Moh, Changwat Phra Nakhon Si Ayutthaya (Ukkatawewat and Ratanalhauee 1978). The species also occurs in the lower Mekong, downstream from the Thai border (Rainboth et al. 1976).

Geographical Status: C. caeruleostigmata is endemic to the Mae Nam Chao Phraya, Thailand, and the lower Mekong.

Habitat Requirements and Habitat Trend: Habitat consists of large, turbid rivers (IUCN 1977).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Exportation as an aquarium fish is the only reported threat (IUCN 1977).

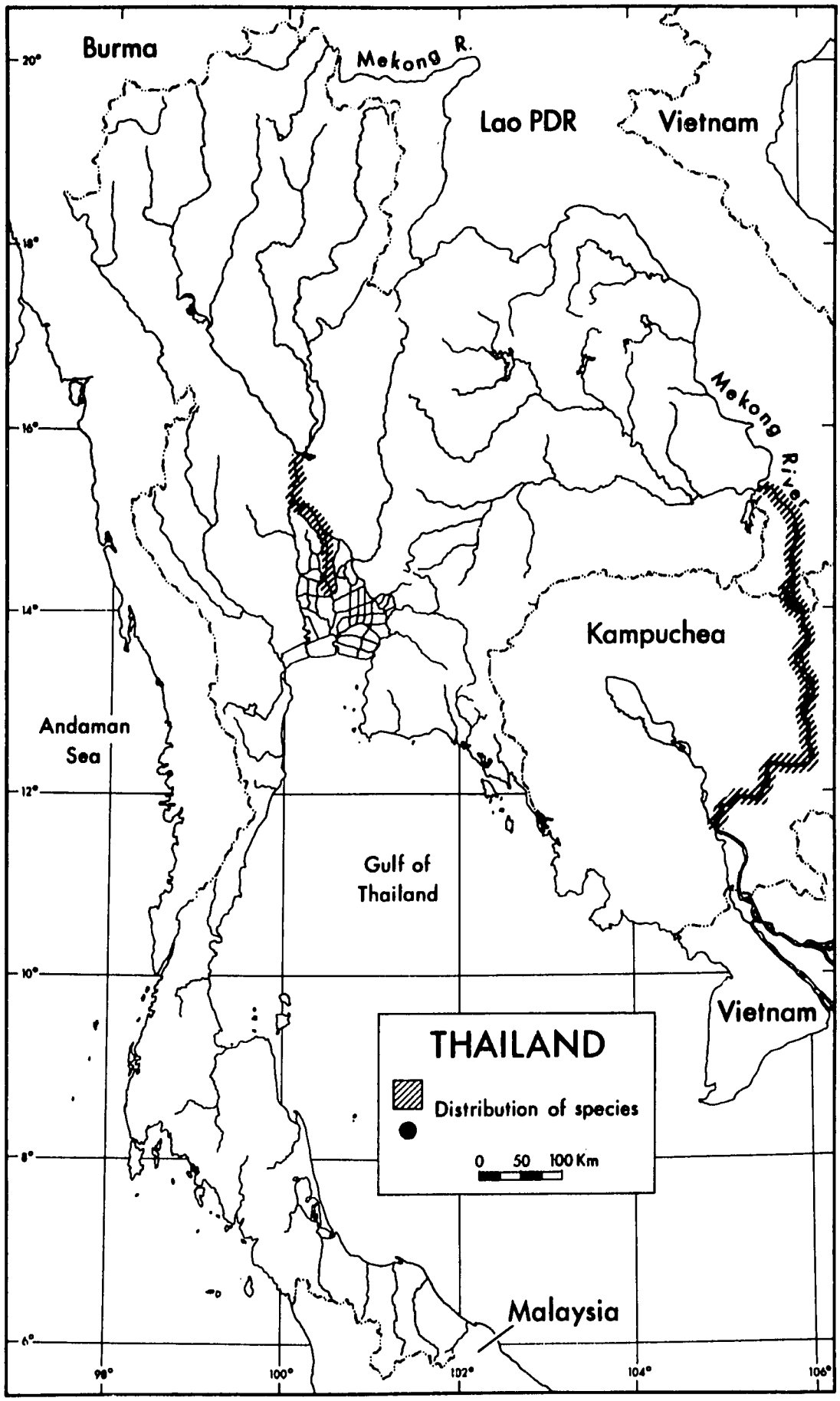
Responses to Habitat Modification: Unknown. Impoundment of Bung Boraphet as a reservior may have had significant impacts on this species.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: A field survey of the status of *C. caeruleostigmata* should be conducted to determine the current dimensions of the problem. The extent of aquarium trade should be monitored and halted if the threat is confirmed.



Chela caeruleostigmata

Pla kaho, giant carp

Catlocarpio siamensis Boulenger 1898

Osteichthyes, Cypriniformes, Cyprinidae

Status: Endangered.

Population Size and Trend: C. siamensis was once abundant and a major source of food, but now it is very rare and might be extripated from Thailand. One of the largest cypriniform fishes in the world, this species formerly reached 2.5-3 m in size (Smith 1945).

Distribution and History of Distribution: The giant carp occurred throughout the Mae Nam Chao Phraya, from Pak Nam north, and up its tributaries at least as far as Ratchaburi on the Mae Nam Mae Klong, Lop Buri on the Mae Nam Bang Kham, and Dha Luang (possibly Nakhon Luang in Changwat Phra Nakhon Si Ayutthaya) on the Mae Nam Pa Sak. It bred in Bung Boraphet and other swamps that receive Chao Phraya floodwater (Smith 1945). The most recent specimen taken in the Mae Nam Chao Phraya, in 1969, was 1.45 m long and weighed 80.5 kg (Sompote Ukkatawewat, personal communication). Giant carp also occurred in the Mekong from Luang Prabang, Lao PDR, downstream to southern Vietnam and Tonle Sap, Kampuchea; Thai localities include Ban Pak Som at the mouth of Huai Nam Som, Nong Khai, Mukdahan, Khemmarat, and above Tha Tum on the Mae Nam Mun (Rainboth et a.. 1976). However, no specimens of giant carp were reported from recent sampling of the Mekong by Lagler.

Geographical Status: This is a basinwide, mainstream, riverine fish.

Habitat Requirements and Habitat Trend: Habitat is large rivers, but the fish enter ponds, canals, and swamps connected to the rivers. Smith (1945) indicates that breeding occurs in swamps. The diet consists of algae, plankton, and plant seeds (Ukkatawewat 1979).

Vulnerability of Species and Habitat: The species is considered fairly good to eat and is vulnerable to overfishing, which has caused its decline. Its riverine habitat is vulnerable to impoundment.

Causes of Threat: C. siamensis is endangered by excessive harvest. Loss of this species to impoundment of its habitat in the Mekong has been predicted by Lagler (1976a).

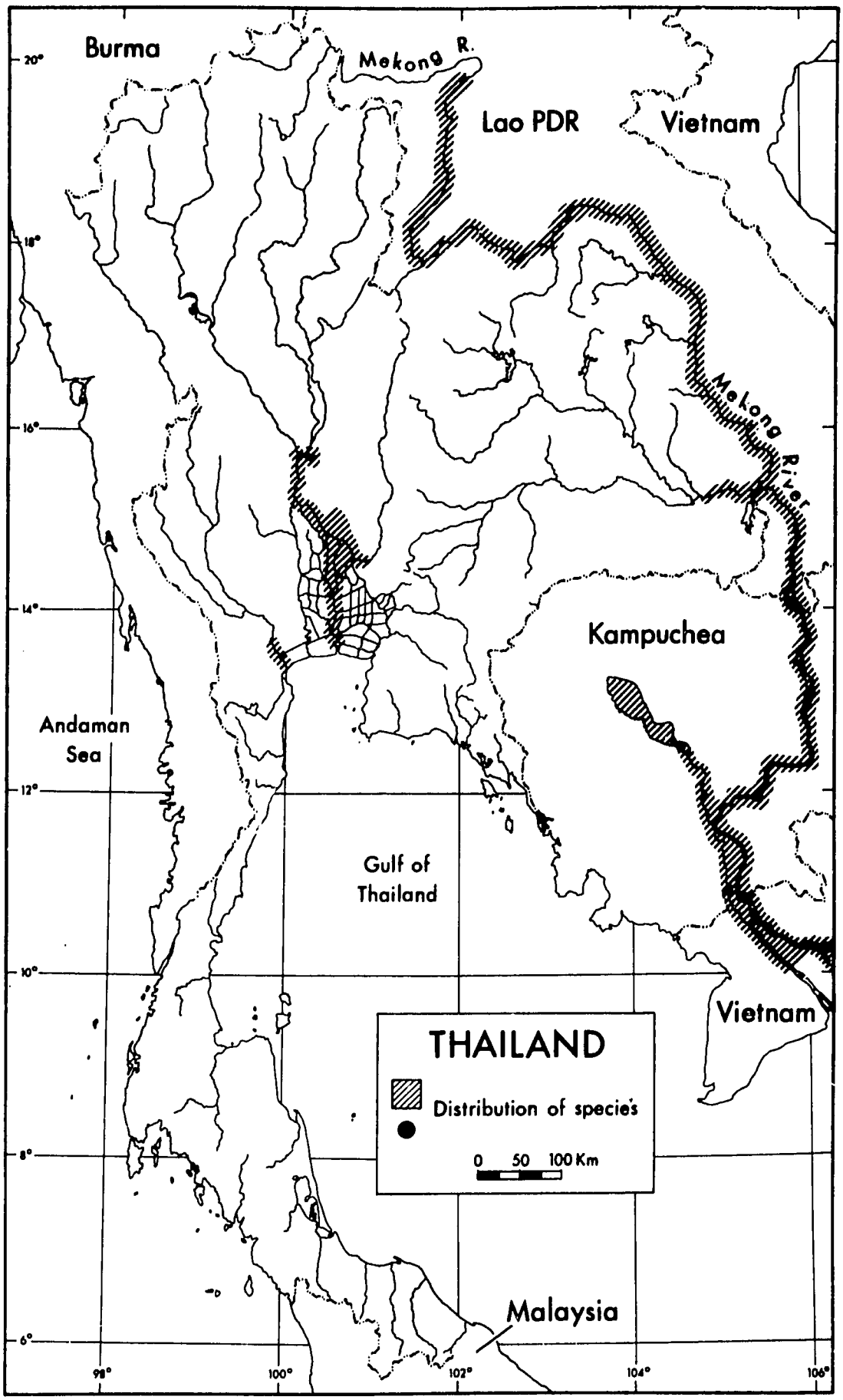
Responses to Habitat Modification: Unknown. The ability of giant carp to live in reservoirs has not been tested, but records of its presence in Tonle Sap, Kampuchea, suggest the possibility.

Demographic Characteristics: Natality depends on size of the female. One weighing 61 kg is reported with 11 million eggs, whereas one of 55 kg had about 5 million. Hatching time at 29.3° C is 12 hours (Ukkatawewat 1979).

Key Behaviors: Spawning occurs between July and September (Ukkatawewat 1979).

Conservation Measures Taken: Captive breeding methods have been developed by the Thai Inland Fisheries Division, but no propagation and restocking program has been implemented (Suebsin Sontirat personal communication).

Conservation Measures Proposed: Fishing for giant carp should be closed while a survey is undertaken to determine what populations remain in the wild. A reintroduction program should be accompanied by a continued closed season, experimental restocking in reservoirs, and research to determine what harvest level will be compatible with optimum sustained yield.



Catlocarpio siamensis

Pla yeesok, carp

Probarbus jullieni Sauvage 1880

Osteichthyes, Cypriniformes, Cyprinidae

Status: Threatened.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN (1979): Threatened.
IUCN Red Data Book (1977): Indeterminate.

Population Size and Trend: Populations of this carp were formerly very abundant but have been depleted, except for the Mekong population (Ukkatawewat 1979). Populations were estimated at fewer than 500 individuals in Malaysia but more than 2000 elsewhere (IUCN 1977). Within the last decade, the species was extirpated from the Mae Klong but reintroduced; the impact of recent habitat destruction is unknown (Sompote Ukkatawewat, personal communication). Davidson (1975) considered P. jullieni to be relatively scarce along the border of Lao PDR. In trawl collections in the Mekong at Khemmarat, Mukdahan, and Nakhon Phanom, Thailand, Lagler (1976a) caught 22 P. jullieni weighing a total of 71 g (sic). In eight beach seine hauls near Nong Khai, Lagler caught 4 P. jullieni weighing a total of 7 g (sic).

Distribution and History of Distribution: The historic distribution of this species included the Mae Nam Chao Phraya, Pa Sak, Mae Klong, and Kwae Noi (Smith 1945, IUCN 1977, Ukkatawewat 1979). Individuals are still being caught in the Chao Phraya (Sompote Ukkatawewat, personal communication). The current status of the Mae Klong population, following episodes of abundance, extirpation, reintroduction, and habitat loss, is unknown. P. jullieni occurred in the Mekong from Luang Prabang, Lao PDR, downstream along the Thai-Lao border, and through Kampuchea and Vietnam, including the lower reaches of the Mae Nam Mun (Rainboth et al. 1976; Lagler 1976a; Ukkatawewat 1979). This part of the range is not known to have changed (Sompote Ukkatewewat, personal communication). Range in Malaysia included the Pahang and Perak rivers, but the Perak population has been extirpated (IUCN 1977). Loss of this population was attributed to construction of the Chenderoh Dam in 1930, halting upstream migration for spawning. The species remained common below the dam until about 1955 but had become rare by 1965 (Alfred 1968).

Geographical Status: The species is widespread in the mainstreams of large rivers of Southeast Asia. However, populations occur only at certain localities within this distribution (Smith 1945, Davidson 1975).

Habitat Requirements and Habitat Trend: P. jullieni lives in large rivers with clear water and sandy or gravel bottoms (Smith 1945, IUCN 1977, Ukkatawewat 1979). Smith noted lower numbers in the mud-bottomed Chao Phraya than in the sand-bottomed Mae Klong. Spawning habitat occurs on sand or gravel river bottoms where the current is about 1.3 m/sec. The diet consists mostly of snails, plus clams, aquatic insects, and aquatic plants (Ukkatewewat 1979).

Vulnerability of Species and Habitat: The limited supplies of excellent meat are in great demand (Davidson 1975), so P. jullieni is vulnerable to overfishing. The habitat with low levels of suspended solids in the water and fine sediment on the bottom is vulnerable to industrial pollution and to siltation caused by deforestation. Riverine habitat is converted to lentic habitat wherever reservoirs are built.

Causes of Threat: Overharvest is one cause of decline in numbers (IUCN 1977). Extirpation from the Mae Klong was caused by effluent sugar refinery wastes. Though P. jullieni were reintroduced above the pollution source, the Si Nakrin Dam has impounded most of the remaining habitat. If the Pa Mong Dam is built, habitat along the upper Mekong will be altered by impoundment above the dam and reduced water flow below the dam. Lagler (1976a) predicted the loss of P. jullieni from waters affected by the dam. Though the species occurs in the mainstream near the proposed dam site, it was not found in the Lam Dom Noi, Lam Pao, and Nam Pong reservoirs. If the Thai populations are migratory, dams built between spawning grounds and downstream range would break the reproductive cycle, resulting in loss of the affected population in a few years.

Responses to Habitat Modification: Unknown. Observed spawning habitat suggests that P. jullieni may be unable to reproduce in reservoirs.

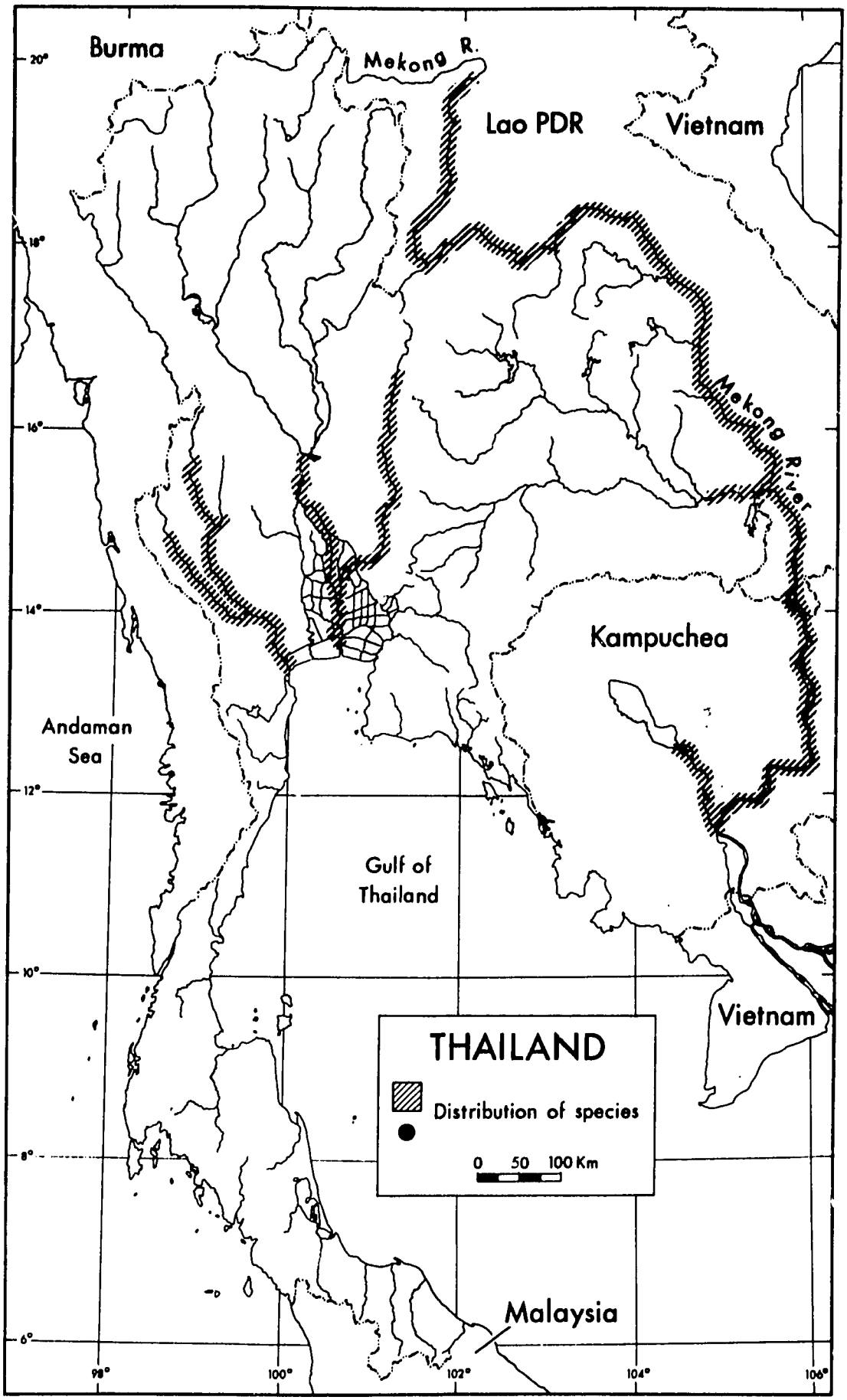
Demographic Characteristics: A female weighing 14 kg contained about 500,000 eggs (Ukkatawewat 1979).

Key Behaviors: Spawning in Thai waters occurs from late December to early February. In Malaya, P. jullieni migrates upriver to spawn (Alfred 1968).

Conservation Measures Taken: The Thailand Inland Fisheries Division is breeding P. jullieni in captivity at Nong Khai, producing about 2 million fry per year for release. Developing successful techniques resulted from a concerted research effort over several years.

Conservation Measures Proposed: Conservation of this important resource by replenishing depleted or extirpated populations with hatchery-reared fish depends on maintaining suitable habitat. Pollution from existing industrial facilities should be halted by treating or storing waste water, and new sources of pollution should be permitted only after a waste treatment and monitoring program is designed into the

overall development plan. Actual use of reservoirs could be determined by monitoring fish in the Si Nakrin reservoir and upstream in the Mae Klong. Similar tests could be conducted by releases in and upstream of other reservoirs. The impact on fishery resources by the altered hydroperiod downstream from dams is another necessary area of research. For populations not threatened by habitat loss, studies of population and harvest dynamics would lead to a management strategy compatible with longterm sustainable use of the resource. Mark-recapture studies of tagged fish to document possible migratory movements would indicate whether dams could halt reproduction by blocking migration. Comprehensive research on habitat use, spawning, and movements should clarify where hydroelectric dams could be built without damaging this natural resource.



Probarbus jullieni

Tapien, barb, olive carp

Puntius sarana (Hamilton 1822)

Osteichthyes, Cypriniformes, Cyprinidae

Status: Threatened.

Population Size and Trend: Unknown. Apparently this species is very rare in Thailand but is an important fishery resource farther west.

Distribution and History of Distribution: P. sarana is known from India, Bangladesh, Burma, and Thailand. Only two specimens are reported from Thailand, one from the Mae Nam Wong and one from the Mekong west of Vientiane (Smith 1945, Rainboth et al. 1976).

Geographical Status: The Thai distribution of P. sarana is peripheral to the species' range.

Habitat Requirements and Habitat Trend: The species is known from rivers, backwaters (Sobhana and Nair 1977) and lakes (Murty 1976). The diet consists of aquatic plants (Murty 1976).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: P. sarana is considered incapable of living in reservoir habitat (Lagler 1976b), so its Mekong population is threatened by the proposed Pa Mong reservoir.

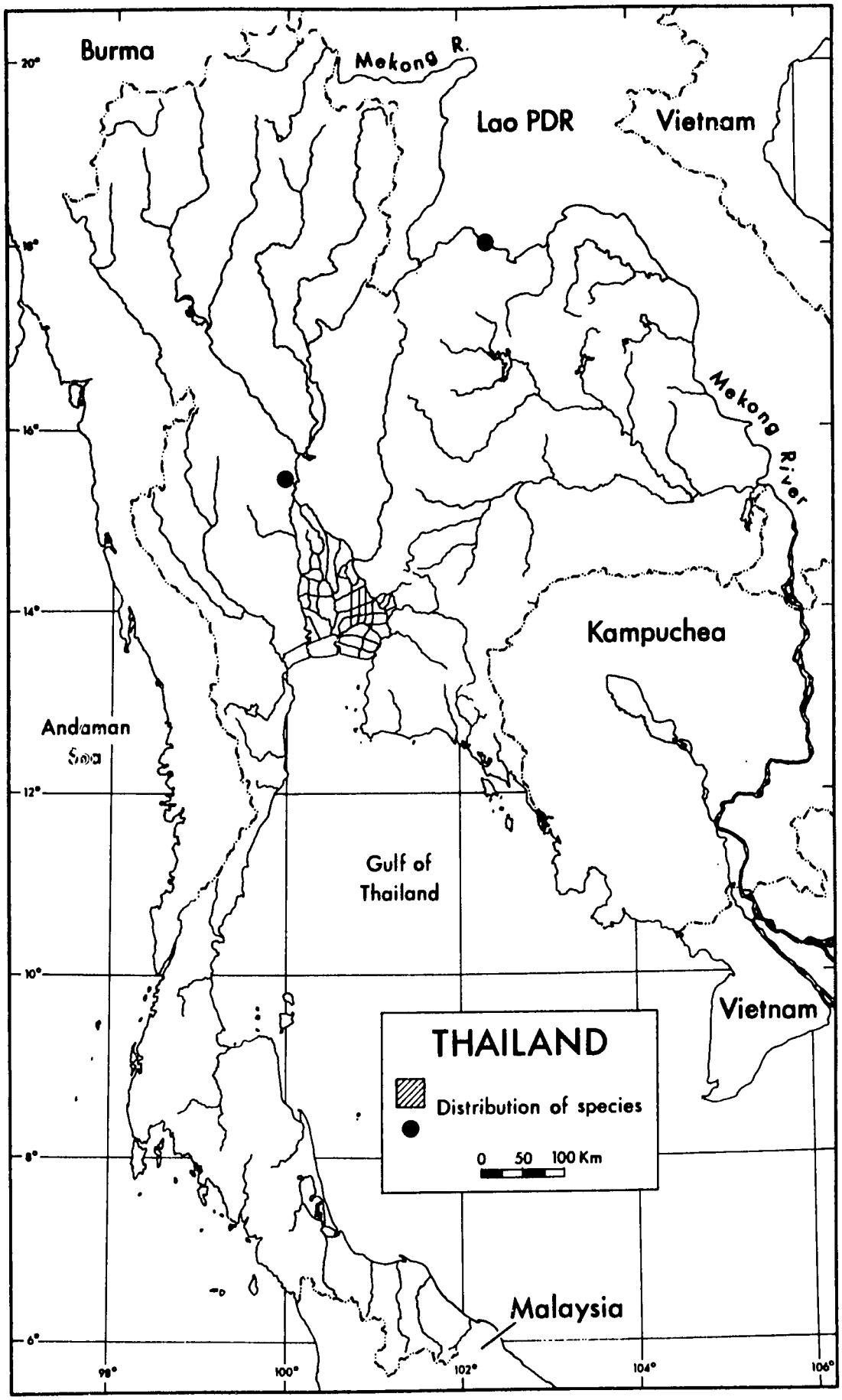
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The average length of females at first maturity is 183 mm. The number of eggs produced ranges from about 15,000 to 140,000 per spawning period. The spawning season in different parts of India variously involves a single batch of eggs in July-August and two batches of eggs in May-November (Sinha 1975, Sobhana and Nair 1978). Growth checks occurring on the scales are not formed annually (Murty 1976).

Key Behaviors: Breeding in southwestern India occurs from May to November (Sobhana and Nair 1977).

Conservation Measures Taken: None.

Conservation Measures Proposed: The distribution of *P. sarana* in Thailand and its ability to live in lentic habitat need to be investigated.



Puntius sarana

Pla hang mai, burnt-tail carp

Balantiocheilos melanopterus (Bleeker 1851)

Osteichthyes, Cypriniformes, Cyprinidae

Status: Probably extirpated.

Population Size and Trend: Once common in Thai rivers (Smith 1945, Rainboth et al. 1976), B. melanopterus apparently has been extirpated from the country (Sompote Ukkatawewat, personal communication).

Distribution and History of Distribution: Original distribution of this species included the entire basin of the Mae Nam Chao Phraya from Bangkok to Nakon Sawan, to Chiang Mai on the Mae Nam Ping, the lower Mae Nam Nan and Bung Boraphet, and the Mae Nam Pa Sak to Dha Luang (possibly Nakhon Luang in Changwat Phra Nakhon Si Ayutthaya) (Smith 1945). Distribution also included the lower Mekong basin, from Tonle Sap and its drainage into the Mekong, up to Khemmarat, Thailand, and Vientiene, and in the lower Nam Ngum, Lao PDR (Rainboth et al. 1976). To the south, this species is known from Borneo, Sumatra, and Malaya.

Geographical Status: B. melanopterus is a basinwide, mainstream, freshwater species.

Habitat Requirements and Habitat Trend: Unknown.

Vulnerability of Species and Habitat: The species is highly vulnerable to capture.

Causes of Threat: The apparent extirpation of this species from Thailand was caused by excessive harvest for the aquarium trade. At present the demand within Thailand is being satisfied by importation of the species from Indonesia (Sompote Ukkatawewat, personal communication).

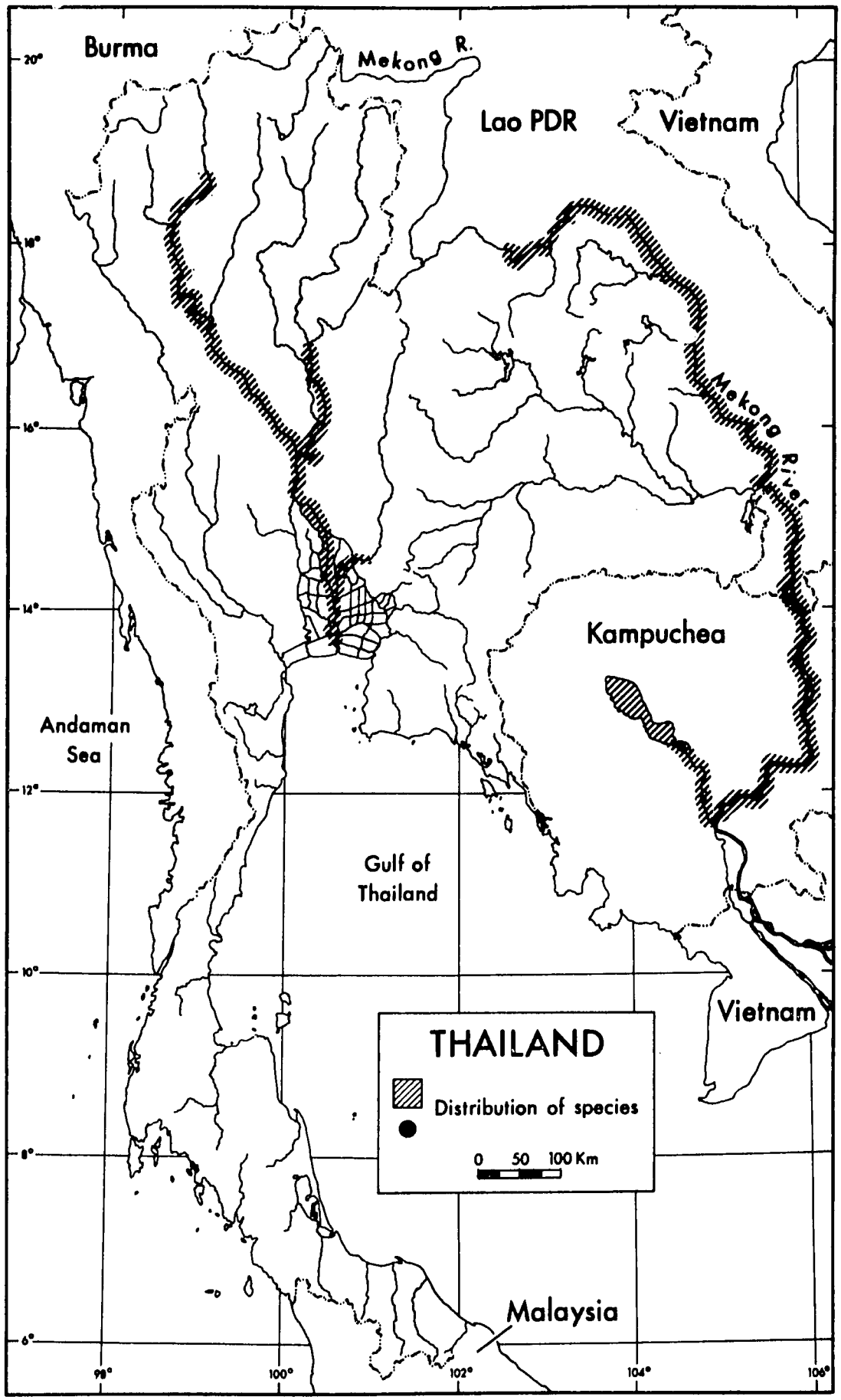
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None

Conservation Measures Proposed: The economic value of this renewable resource could be restored by research on captive propagation and habitat requirements, based on non-native stock. A reintroduction program should be accompanied by a closed season and research to determine what harvest level would be compatible with optimum sustained yield.



Balantiocheilus melanopterus

Carp

Labeo behri Fowler 1937

Osteichthyes, Cypriniformes, Cyprinidae

Status: Endangered.

Population Size and Trend: Unknown.

Distribution and History of Distribution: Published information indicates that L. behri is restricted to the Mekong, from its confluence with the Mae Nam Mun, Thailand, upstream to Luang Prabang, Lao PDR (Rainboth et al. 1976). A single specimen is ascribed to Bangkok (Smith 1945). However, the species also is reported to occur in the Mae Nam Mae Klong and Salween in Changwats Kanchanaburi, Tak, and Mae Hong Son (Suebsin Sontirat personal communication).

Geographical Status: Most of the range of this species occurs along the Thai border.

Habitat Requirements and Habitat Trend: Habitat is the mainstream of a large river. No other information is available.

Vulnerability of Species and Habitat: The entire species is vulnerable to the series of dams and navigation channels planned along the length of the Mekong, from Kampuchea to Luang Prabang.

Causes of Threat: L. behri is not expected to be able to establish itself in impoundments (Lagler 1976b) and hence may become extinct if the Mekong developments take place.

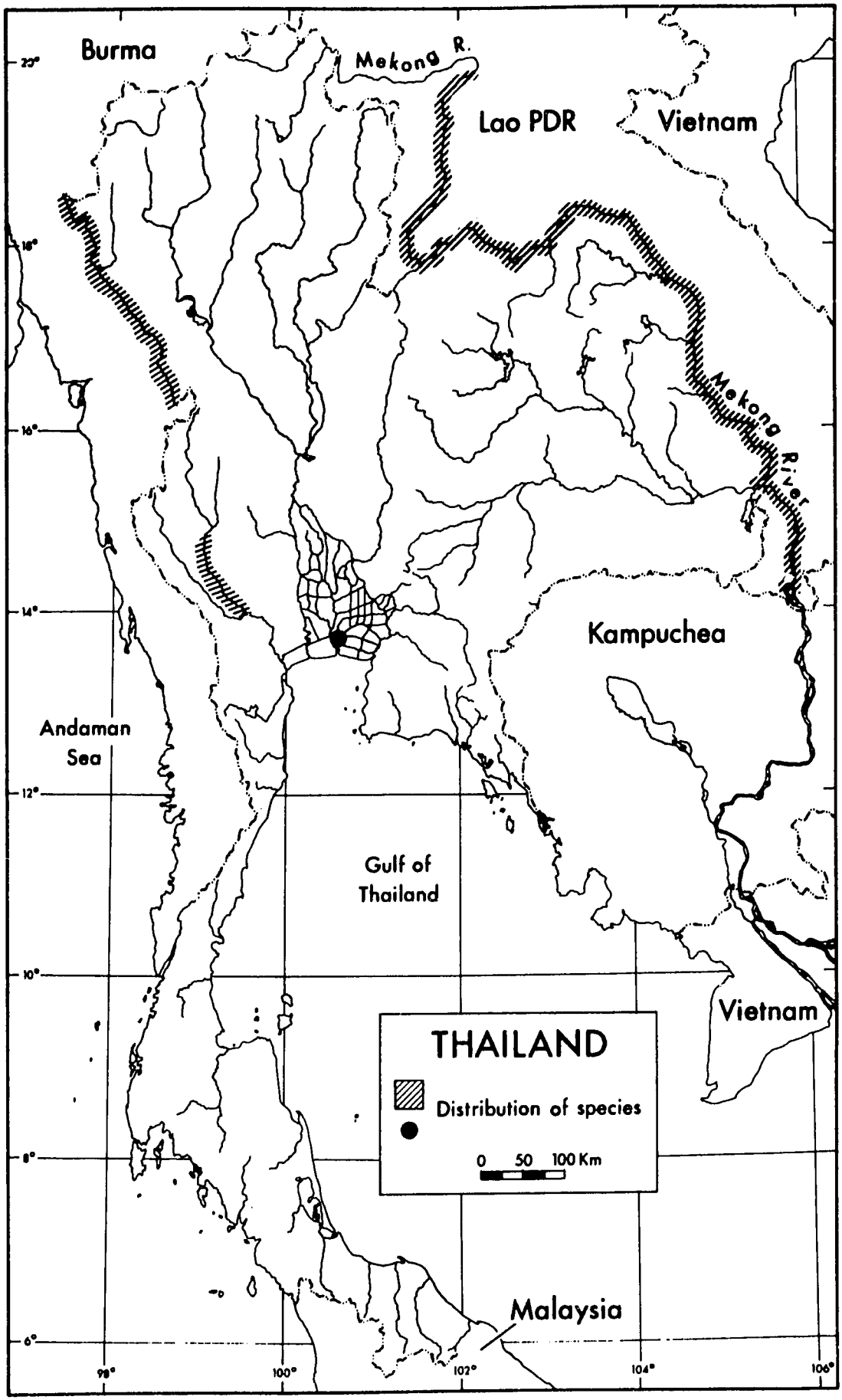
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: A survey is needed to determine the current status of *L. behri* populations, and the ability of the species to live in reservoirs should be investigated. Current information indicates that mainstream dams on the Mekong should be avoided in order to conserve this species.


Burma
Mekong R.
Lao PDR
Vietnam
Mekong River
Kampuchea
Andaman Sea
Gulf of Thailand
Vietnam
THAILAND
Distribution of species
0 50 100 Km
Malaysia
20°
18°
16°
14°
12°
10°
8°
6°
98°
100°
102°
104°
106°

Labeo behri

Pla nam fai, backwater fish

Xenocheilichthys gudgeri Smith 1934

Osteichthyes, Cypriniformes, Cyprinidae

Status: Endangered.

Population Size and Trends: Though thought by Smith (1945) to be rare, X. gudgeri is common in the Mekong. It was among the most important species taken in trawl collections near Khemmerat-Mukdahan-Nakhon Phanom and in beach seining near Vientiane-Nong Khai (Lagler 1976a).

Distribution and History of Distribution: X. gudgeri is known from the upper Mae Nam Nan, near Nan, Thailand (Smith 1945), from the Mekong from southern Vietnam upstream to Luang Prabang, Lao PDR, and from the lower Mae Nam Mun to Ubon Ratchathani (Rainboth et al. 1976). The species also has been recorded in the Lancang River, Yunnan Province, China (Li 1976).

Geographical Status: Nearly the entire species' range is in Thailand or along its borders.

Habitat Requirements and Habitat Trend: Habitat is the mainstream of large rivers. No other information is available.

Vulnerability of Species and Habitat: The species is vulnerable to the five mainstream dams and navigation channels planned along the Mekong from Sambor to Luang Prabang.

Causes of Threat: X. gudgeri is not expected to be able to establish itself in impoundments (Lagler 1976b) and hence may become extinct if the Mekong developments take place.

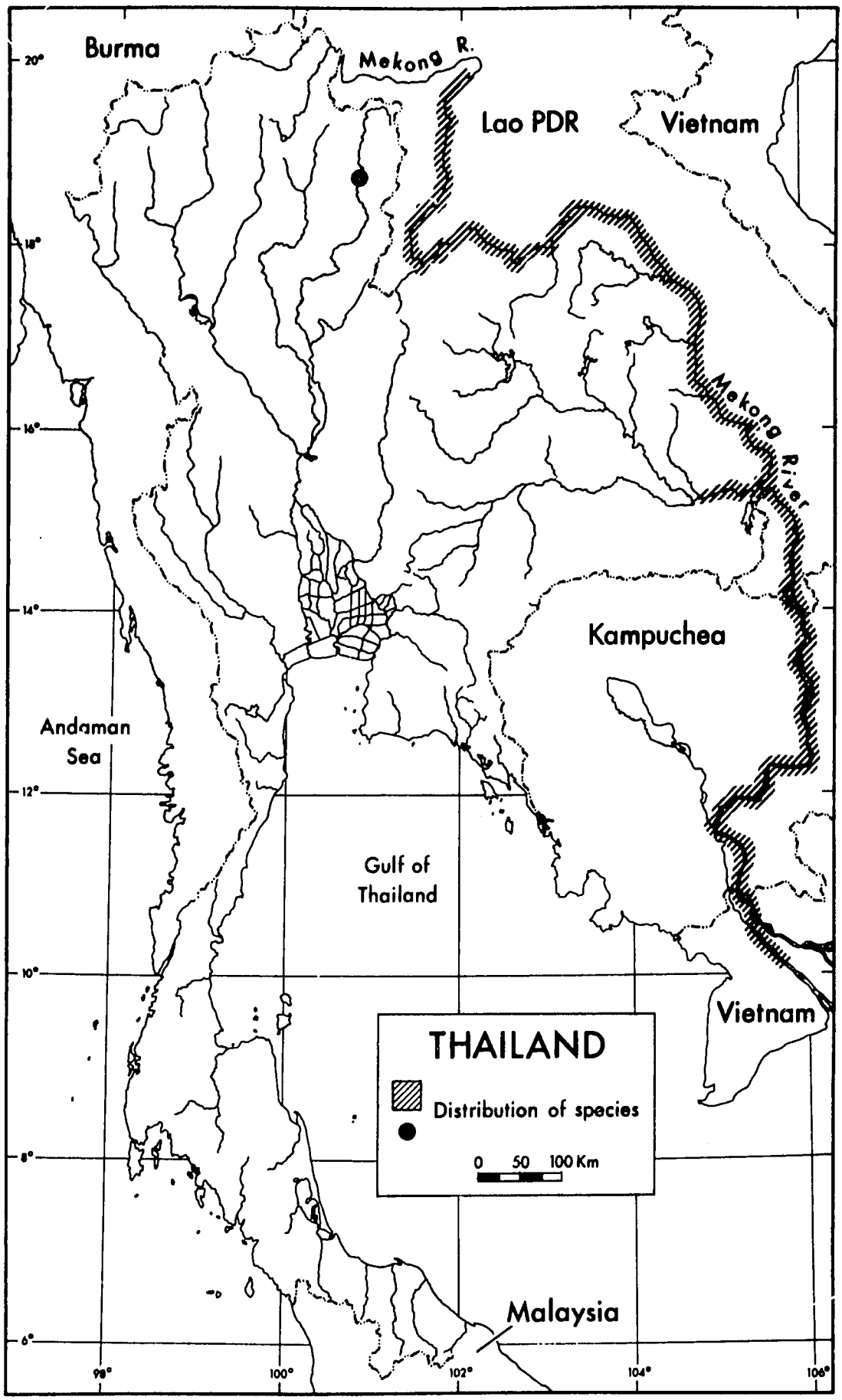
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: The ability of this species to live in reservoirs should be investigated. Current information indicates that mainstream dams on the Mekong should be avoided in order to conserve this species.



Xenocheilichthys gudgeri

Catfish

Hemisilurus heterorhynchus (Bleeker 1853)

Osteichthyes, Siluriformes, Siluridae

Status: Endangered.

Population Status and Trend: Unknown.

Distribution and History of Distribution: *H. heterorhynchus* is known from Sumatra, Borneo, and the lower Mekong basin. Its continental distribution is in the Mekong from Pakse, Lao PDR, upstream to Mukdahan, Thailand, and in the Mae Nam Mun from its confluence with the Mekong upstream to Ubon Ratchathani (Weber and De Beaufort 1965, Rainboth et al. 1976).

Geographical Status: This continental population has a small range and appears to be relictual.

Habitat Requirements and Habitat Trend: Habitat is the mainstream of large rivers. No other information is available.

Vulnerability of Species and Habitat: The species is vulnerable to the series of dams and navigation channels planned along the Mekong.

Causes of Threat: *H. heterorhynchus* is not expected to be able to establish itself in impoundments (Lagler 1976b) and hence may become extirpated if the Mekong developments take place. Dams that block migration would halt reproduction.

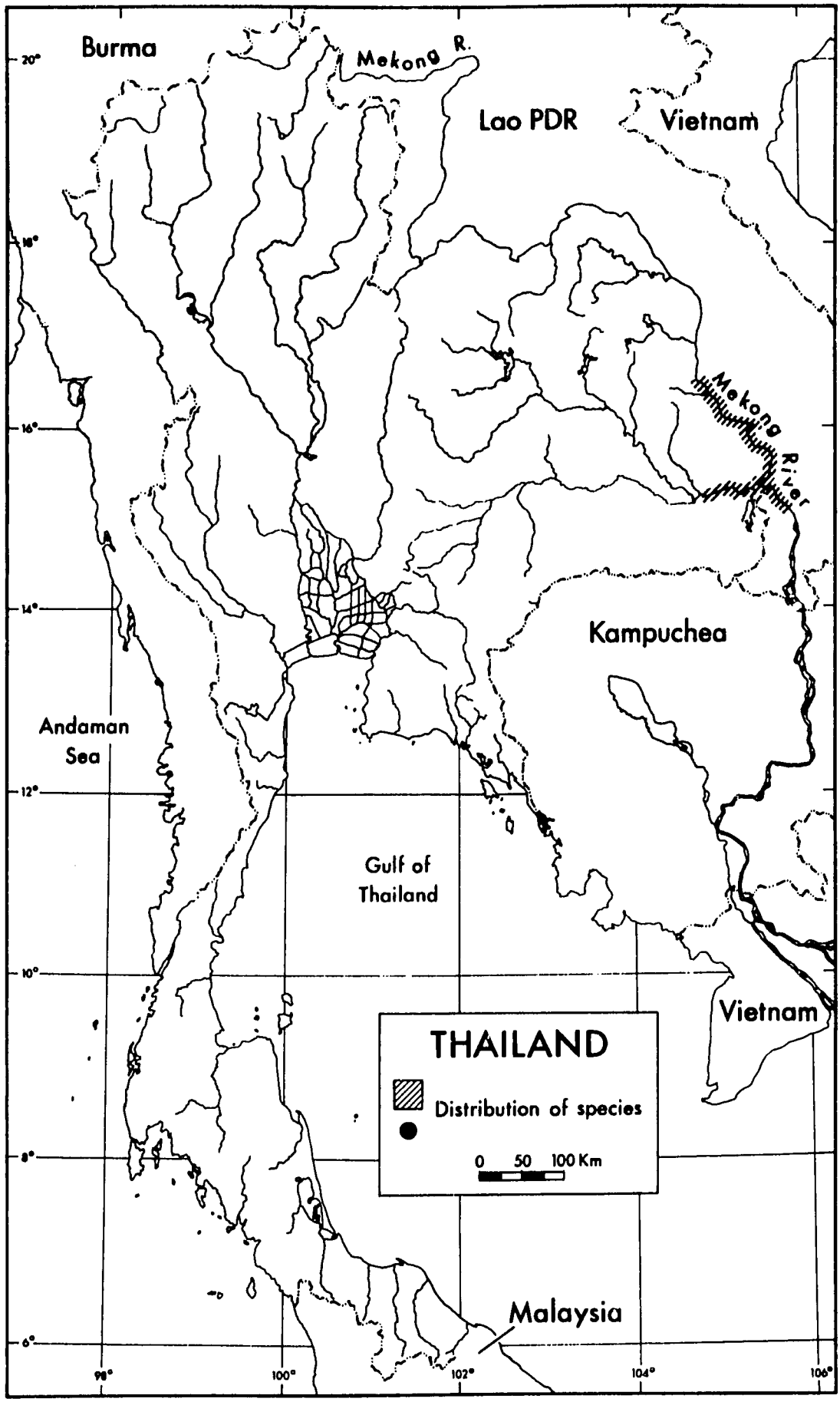
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown. A high proportion of this species in samples during June high water was interpreted by Lagler (1976a) as evidence of a migration in progress.

Conservation Measures Taken: None.

Conservation Measures Proposed: A survey is needed to determine the current status of the *H. heterorhynchus* population, and the ability of the species to live in reservoirs should be investigated. Current information indicates that mainstream dams on the Mekong should be avoided in order to conserve this species.



Hemisilurus heterorhynchus

Pla duk lampan, a walking catfish

Prophagorus nieuhofi (Cuvier and Valenciennes 1840)

Osteichthyes, Siluriformes, Clariidae

Status: Threatened.

Population Size and Trend: Unknown.

Distribution and History of Distribution: P. nieuhofi in Thailand is known from very few specimens. The records are from southeastern Thailand, at Nong Khor, near Si Racha, Ban Hup Bon near Si Racha, and from the Mae Nam Trat near Khao Saming (Smith 1945). Additional records are from Patthalung and from Lang Suan in Changwat Chumphon (Areeratana 1970). Elsewhere the species is known from the Philippines, Malacca, and many islands in the Indo-Australian Archipelago. Suebsin Sontirat (personal communication) states that distribution in Thailand is in Changwats Satun, Narathiwat, Patthalung, and Pattani.

Geographical Status: The species is peripheral in Thailand.

Habitat Requirements and Habitat Trend: Unknown.

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Unknown.

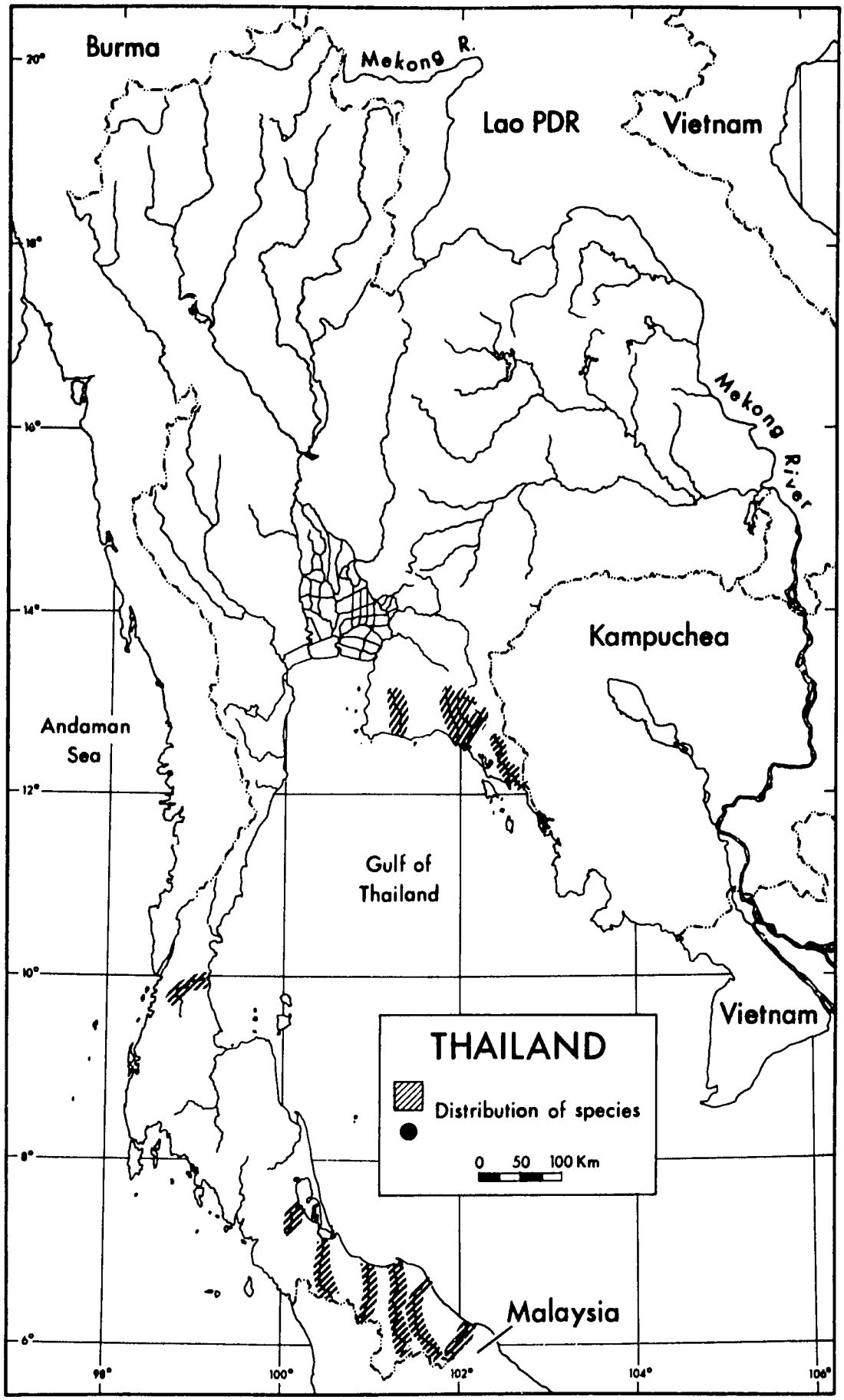
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown. Maximum length was reported to Smith (1934) as about 0.5 m.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservations Measures Proposed: A survey is needed to verify the status of *P. nieuhofi* and determine what conservation measures are appropriate. Fish farming methods developed for other Thai walking catfish (Sidthimunka 1972) might be useful in captive propagation of this species.



Prophagorus nieuhofi

Pla thepa, Sanitwongse's catfish

Pangasius sanitwongsei Smith 1931

Osteichthyes, Siluriformes, Pangasiidae

Status: Endangered.
USFWS (1980a): Endangered.
IUCN (1968, 1979): Threatened.
IUCN Red Data Book (1977): Rare.

Population Size and Trend: Numbers in 1967 were estimated at fewer than 2000 (IUCN 1977); no recent estimate is available. Based on the trend in the size of harvested fish, Smith (1945) stated that "its numbers appear to be decreasing yearly with the increase in the activity and efficiency of fishing operations."

Distribution and History of Distribution: P. sanitwongsei occurs in the Mae Nam Chao Phraya and its tributaries, including the Mae Nam Ping to above Raheng (Smith 1945). It also occupies the Mekong from Luang Prabang, Lao PDR, along the Thai-Lao border, through Kampuchea to Vietnam, including the lowest portion of the Mae Nam Mun, Thailand (Rainboth et al. 1976).

Geographical Status: The species is a mainstream, freshwater, riverine fish.

Habitat Requirements and Habitat Trend: These fish occupy deep areas of rivers, with only young occurring short distances up minor tributaries. Individuals in rivers confluent with Bung Boraphet do not enter the swamp during annual floods. During flood stage, the fish stay in deep holes in the rivers (Smith 1945). Spawning habitat has not been described. Diet is not documented but is reputed to include dogs (Smith 1945).

Vulnerability of Species and Habitat: P. sanitwongsei is vulnerable to overfishing despite the relatively low quality and excessive fat in its meat. Fishing for this species formerly was constrained by cultural rites, as for P. gigas (Davidson 1975). Large portions of riverine habitat would be converted into lentic habitat where reservoirs are constructed. If, as suspected, P. sanitwongsei undergoes a spawning migration, construction of dams would prevent reproduction.

Causes of Threat: Loss of this species to impoundment of its habitat has been predicted by Lagler (1976a). Excessive harvest is the primary threat and has been a continuous problem since about 1920 (Smith 1931). Capture of individuals 3 m long was relatively common prior to that time, but the largest one seen by Smith was 2.5 m, and most of the fish reaching the Bangkok market were 0.4-0.6 m long (Smith 1945).

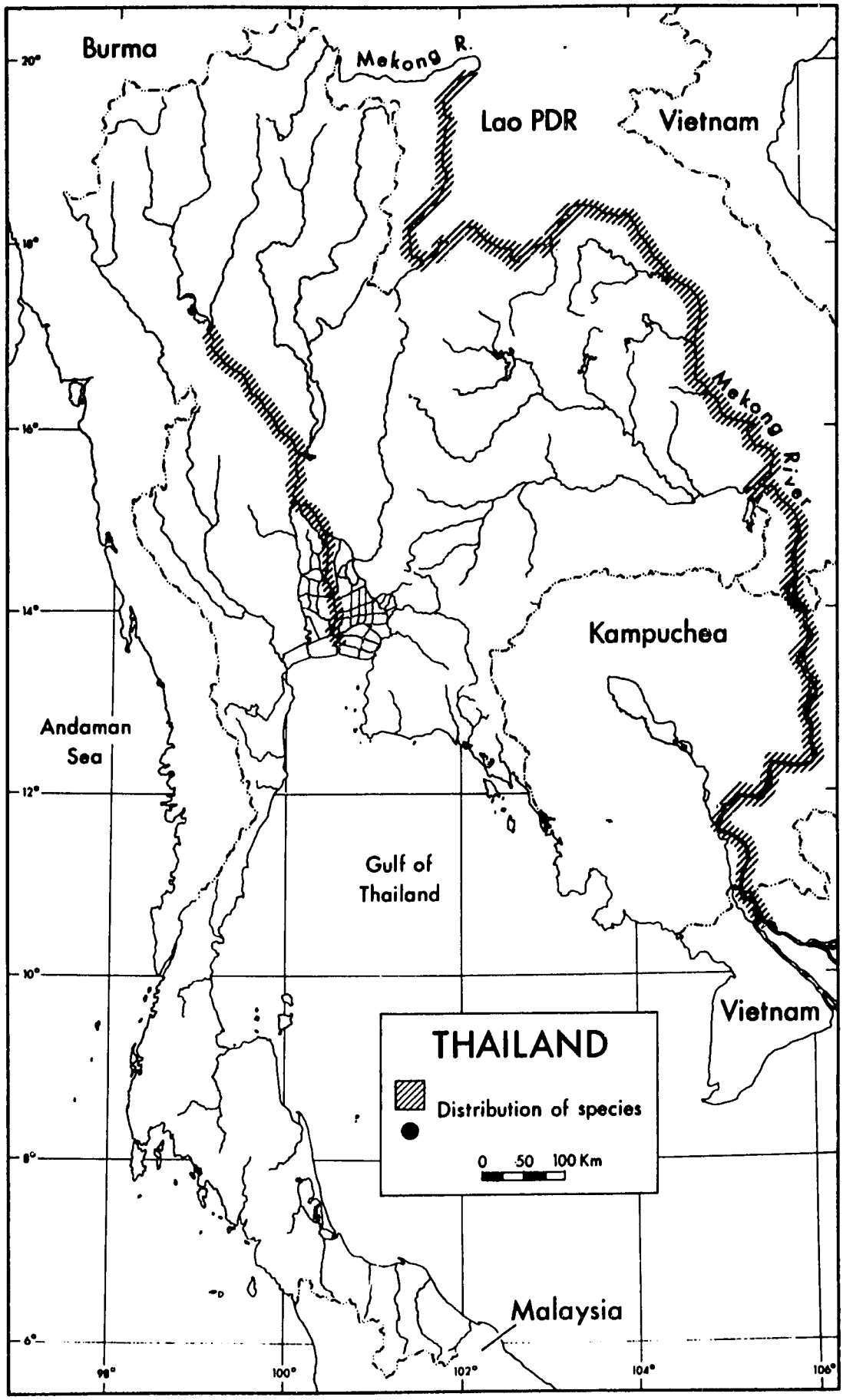
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Migration to spawning grounds is suspected but not documented (Lagler 1976).

Conservation Measures Taken: None.

Conservation Measures Proposed: The status of *P. sanitwongsei* appears to warrant prohibiting harvest while research is undertaken on habitat, movements, and population dynamics. This information should lead to a management strategy that would permit harvest on a long-term, sustainable basis. Habitat information would be helpful in determining where riverine fisheries should be avoided in planning reservoirs.



Pangasius sanitwongsei

Pla buk, giant catfish

Pangasianodon gigas Chevey 1930

Osteichthyes, Siluriformes, Pangasiidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN (1979), IUCN (1968): Threatened.
IUCN Red Data Book (1977): Vulnerable.

Population Size and Trend: Population size is unknown, but several authors indicate a declining trend. Seidenfaden (1923) reported the annual catch for 1890 as 6000 individuals at Vienchan and 1000 at Pak Lai, Lao PDR. According to Smith (1945), the annual catch was 40-50 P. gigas at a depression in the Mekong (Wang pla buk) at Ban Pha Tang, Changwat Nong Khai, during the 1930's whereas in the October-December fishing season of 1967 only 11 individuals were captured there (average length 2.4 m, range 2.0-2.9 m; Pookaswan 1969). At Vientiane, Lao PDR, about 30 P. gigas are sold annually, with more at the end of the year than in the spring season (Davidson 1975). At Luang Prabang, Lao PDR, and Ban Xieng Mene, Thailand, the catch has declined from a norm of a dozen per year prior to 1965; three were caught in 1968, one in 1969, two in 1970, one in 1971, and none in 1972-1974 (Davidson 1975). At Ban Houei Sai, Khoueng Houa Khong, Lao PDR, the catch averages between 20-30 P. gigas in spring; the harvest was 34 fish in 1973 and 14 in 1974 (1974 average weight 160 kg, range 135-200 kg, Davidson 1975).

Distribution and History of Distribution: This fish occupies the Mekong River and its tributaries, and no changes in distribution are known. Its range in the Mekong extends from the Vietnam-Kampuchea border through Kampuchea, along the borders of Thailand and Burma, and into Yunnan Province, China. Occupied tributaries include the Tonle River and Tonle Sap (Great Lake) of Kampuchea; the Mae Nam Mun, Mae Nam Songkhram, and Mae Nam Kok of Thailand; the Yangpi River and Erh Hai ("Lake Tali") of China (Smith 1945, Pookaswan 1969, Rainboth et al. 1976). The distribution of young and half-grown fish has not been described, but small individuals have been reported in southern China (by Chinese biologists to Sompote Ukkatawewat, personal communication). The species has not been recorded in the mouth of the Mekong nor in the South China Sea.

Geographical Status: The species is a basinwide, mainstream, freshwater, riverine fish.

Habitat Requirements and Habitat Trend: The habitat of adults is mainstream waters of large rivers, especially in basins and deep depressions with a gravel or rubble bottom (Smith 1945, Pookaswan 1969). Here the diet consists of algae grazed from stones in the river bed; frequently the digestive tract contains small stones swallowed during grazing (Smith 1945). Spawning habitat is in Erh Hai, China (Davie 1904, in Smith 1945), and in the Mae Nam Songkhram about 60 km NW of Nakhon Phanom (Lagler 1976b), but has not been described, nor has habitat of young and half-grown *P. gigas*. Habitat trends appear to be minimal, but significant reduction of habitat is imminent due to reservoirs planned along the Thai portion of the Mekong and several tributaries.

Vulnerability of Species and Habitat: The species is highly vulnerable to dams that would prevent upstream migration to spawning areas, preventing reproduction by downstream members of the population. *P. gigas* is prized because of its size and high-quality meat, so it also is vulnerable to overfishing, which may have resulted in the observed decline in catch rate. Excessive harvest may have been avoided prior to the mid-1900's by a cultural tradition that synchronized fishing to the post-spawning phase of the reproductive cycle and may have limited the harvest period to three days (Pookaswan 1969; Serène, in Davidson 1975). However, no restraints on harvest remain in place. Large portions of riverine habitat would be converted into lentic habitat when reservoirs are filled.

Causes of Threat: Loss of this species to impoundment of its habitat has been predicted by Lagler (1976a). The most serious consequence would be inaccessibility of its traditional spawning grounds to some or all of the population. Overharvest is an equally serious though more gradual threat; if the current population trend continues, the species will become extinct. The economics of resource exploitation (Clark 1973) are expected to accelerate the trend.

Responses to Habitat Modification: Unknown.

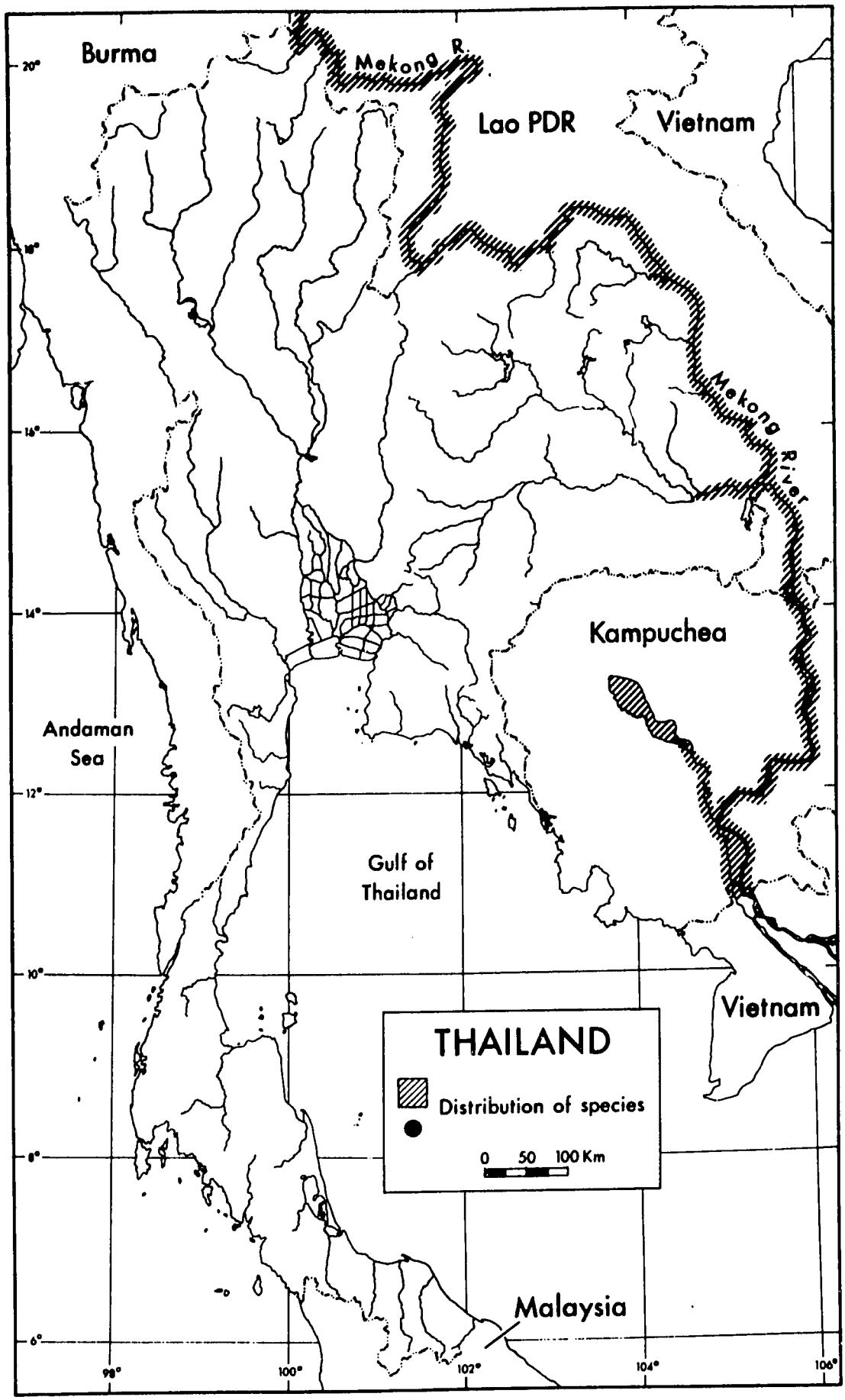
Demographic Characteristics: Based on vertebral annuli Pookaswan (1969) estimated the age of a male *P. gigas* (weight 135 kg, length 2.3 m) at 6 years old. He cited a report from a fisherman that a female of equal length contained ovaries weighing 16 kg and millions of eggs each about 5 mm in size. Formerly individuals reached 3 m in length (Smith 1945), making this one of the largest catfish species in the world.

Key Behaviors: Adult *P. gigas* undergo long-distance migration to spawn, reportedly moving from the lower Mekong Basin to spawning habitat in Erh Hai, China (Smith 1945). Presumably such migration also occurs to the reported spawning ground in the Mae Nam Songkhram. Reports on the timing of migration are not consistent with a synchronous, range-wide migration, and probably the pattern is more complex. According to Smith (1945), the fish travel upstream as floodwater subsides after the rainy season (May-September), reaching Luang Prabang, Lao PDR, by February. Prior to

this upstream movement, fish in Kampuchean waters are very fat and hence undesirable as food; by the time they reach Luang Prabang, little fat remains and the sex glands are enlarged. The downstream movement after spawning ceases by June at Luang Prabang (Pavie 1904, in Smith 1945). In contrast, Davidson (1975) reported that at Ban Houei Sai, Khoueng Houa Khong, Lao PDR (about 275 km upstream from Luang Prabang), the upstream movement occurs during six weeks in late April and May, when the river is just beginning to rise. Females caught at this time are laden with eggs. Davidson also reported two periods of P. gigas catch at Vientiane, Lao PDR, one in spring and the other in the last few months of the year. Lagler (1976b) summarized fish migration in the middle Mekong as follows: a few species move upstream in February and March, as water level approaches the annual minimum; most species migrate upstream in late April, May, and June, as water level rises; and downstream migration occurs from September through November, as annual floodwater begins to recede.

Conservation Measures Taken: Efforts are underway in Thailand to breed this species aquaculturally (Lagler 1976b).

Conservation Measures Proposed: By proceeding with tributary reservoirs for necessary hydroelectric power while halting reservoirs on the Mekong, the central core of the adult habitat and migratory pathway of P. gigas (and of a suite of other endangered species) would be left intact. Fishing should be regulated with the objective of reversing the population decline by protecting the breeding stock. Appropriate limits would be to establish a legal minimum size of fish that can be removed from the water and to close the season during the period that fish are moving upstream to spawn. A major advantage of restoring this and other fishery stocks to their former level is that populations harvested at an optimum sustainable yield will supply the greatest possible amount of food to humans over the long term. Because more information is needed to assure the success of a management program, harvests need to be documented on a regular, continuing basis. To monitor size and age classes, each fish harvested should be measured and a vertebra and pectoral spine from each should be collected and analysed. Research on the Mae Nam Songkhram breeding site and a cooperative research program with the Peoples' Republic of China at Erh Hai and confluent waters would produce information on reproductive biology and spawning habitat; tagging of young for recapture during harvest would yield data on survival and movements.



Pangasianodon gigas

Pla soua taw, triple tails

Datnioides microlepis Bleeker 1853

Osteichthyes, Perciformes, Lobotidae

Status: Endangered.

Population Size and Trend: Apparently once abundant, *D. microlepis* has been overharvested for many decades (Smith 1945). The species is nearly extirpated from Thailand (Sompote Ukkatawewat, personal communication).

Distribution and History of Distribution: This species occurs in Thailand, Lao PDR, Kampuchea, northern Vietnam, Borneo, and Sumatra. Thai distribution is in the upper Chao Phraya and lower Mekong basins and the Mae Nam Mae Klong. Historical range included the Mae Nam Chao Phraya, Mae Nam Pa Sak, Mae Nam Nan, and Bung Boraphet. In the Mekong it occurred from southern Vietnam and Tonle Sap to Luang Prabang, Lao PDR, including lower reaches of the Nam Ngum, Lao PDR, and the Mae Nam Mun, Thailand (Smith 1945, Rainboth et al. 1976, Ukkatawewat 1979). The last sizeable populations were reported along the Mekong and Nam Mun in Changwat Nakhon Phanom and Ubon Ratchathani (Ukkatawewat 1979). In 1975, Lagler (1976a) captured 3 juvenile individuals with a total weight of 6 g in 21 trawl collections in the Khemmarat-Mukdahan-Nakhon Phanom section of the Mekong.

Geographical Status: This is a basinwide, freshwater, riverine and lake-dwelling fish.

Habitat Requirements and Habitat Trend: Unknown. Spawning has been reported in Bung Boraphet. The species is adaptable enough to tolerate aquarium life (Smith 1945). Young fish feed on zooplankton, and adult fish eat small shrimps, fish fry, and small fish (Ukkatawewat 1979).

Vulnerability of Species and Habitat: *D. microlepis* is highly vulnerable to overharvesting, because of very high demand for small fish for the aquarium trade and for large fish as food. In some areas, this is considered the best food fish available, (Smith 1945, Ukkatawewat 1979). Prices are typically U.S. $5/kg. (Sompote Ukkatawewat, personal communication).

Causes of Threat: The threat to this species is harvest above sustainable levels.

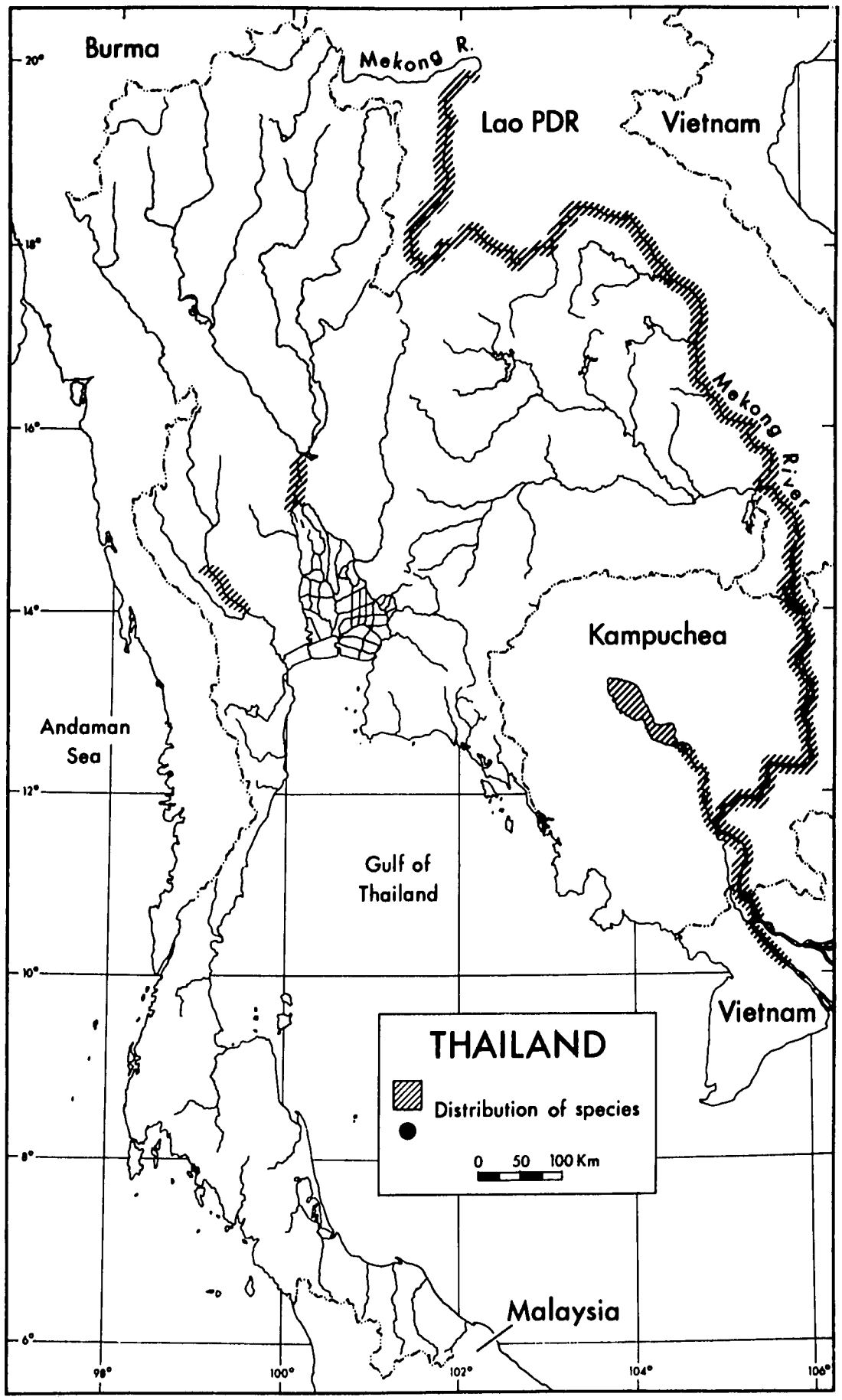
Responses to Habitat Modification: Mostly unknown. When Bung Boraphet was altered from a seasonal swamp to a permanent lake, the population of *D. microlepis* also became permanent instead of temporary. This suggests that the species could live in reservoirs.

Demographic Characteristics: Natality depends on the size of the female. Typical numbers of eggs are 30,000 for a 230 g fish and 720,000 for a 3.6 kg fish. The eggs are very small (1.0-1.2 mm) and float on the water surface in oily clumps. Hatching occurs in 17 hours at 29°C (Ukkatawewat 1979).

Key Behaviors: Spawning occurs from June to August (Ukkatawewat 1979).

Conservation Measures Taken: None.

Conservation Measures Proposed: Harvest of *D. microlepis* should be prohibited while a field survey is undertaken to locate any surviving populations. The high value of this renewable resource could be restored by research on captive propagation and habitat requirements. A reintroduction program should be accompanied by a closed season and research to determine what harvest level should be compatible with optimum sustained yield.



Datnioides microlepis

Kingka nam, ma nam, a primitive salamander

Tylototriton verrucosus Anderson 1871

Amphibia, Caudata, Salamandridae

Status: Threatened.
IUCN (1968): Threatened.

Population Size and Trend: The total population size is unknown. This species is locally common around the town of Taunggyi in Burma (Gyi 1969) and is regularly found at two sites in nothern Thailand.

Distribution and History of Distribution: In Thailand this salamander has been found on Doi Inthanon (2000 m), Doi Chiang Dao (1500-1800 m), and Doi Suthep (1350 m) in Changwat Chiangmai and in Changwat Loei. It is also known from the Kachin Hills (Northern Burma) and Taunggyi (1436 m in the Southern Shan State) in Burma, western Yunnan in China, the Lao PDR, and west as far as Sikkim. Tylototriton was evidently a more widespread genus in the past. Fossils are known from the Miocene of Switzerland (Anderson 1871, Schmidt 1927, Liu 1950, Noble 1954, Taylor 1962, Soderburg 1967, Gyi 1969, Gressitt 1970, Cheke 1973).

Geographical Status: The Thai population is peripheral, lying at the southern limits of the species' range.

Habitat Requirements and Habitat Trend: This animal is found from about 1350-1800 m. The adults are terrestrial, taking shelter during the day under moist, moss-covered rocks, logs, and debris. The aquatic larvae have been found in rocky pools, streams, inundated sand pits, quarries, ponds above and below dams, floodwater, and temporary ponds. The one requirement seems to be that the water be crystal clear. In Burma breeding ponds were noted to range in temperature from 15-21°C. These ponds were rich in aquatic plants, notably algae such as Spirogyra and Chara. Also breeding in the same ponds were molluscs, aquatic larvae of several insect orders (mayflies, dragonflies, and beetles), and the carnivorous serpent-head fishes Ophiocephalus gachua and O. punctatus. The latter two are known predators on Tylototriton. Adults are omnivorous and even cannibalistic at times. The diet includes algae, worms, and a wide array of insects. The aquatic larvae of mosquitos are a preferred food item. Captives readily eat shrimp, rice, and dragonflies. Anglers in Burma frequently capture these newts on hooks baited with worms and pieces of Tylototriton (Taylor 1962, Gyi 1969).

Vulnerability of Species and Habitat: The clear waters this species needs for reproduction are easily polluted by human activities. During synchronous local migrations many adults in Burma are killed by automobiles

and human trampling. Many people regard this animal as an omen of bad fortune and maliciously destroy it on sight (Gyi 1969). It is becoming increasingly attractive to collectors of biological specimens.

Causes of Threat: In Burma certain superstitious people believe that "the water lizard," as they call T. verrucosus, portends ill luck. They kill it at every opportunity. Of the more than 40 individuals Gyi (1969) tagged and released on the campus of Taunggyi College ten were found trampled. A new threat is developing in the form of trade in biological specimens. Gyi advocates the use of this species in zoological teaching laboratories in Southeast Asia to alleviate the expense of importing Salamandra and Necturus from Europe and the United States. Because of its abilities to regenerate lost limbs (Nakamura et al. 1978, for example), it is in growing demand among biomedical researchers. Students of salamander evolution have obtained viable intergeneric hybrids by crossing T. verrucosus and its relative, Pleurodeles waltii (Ferrier et al. 1971, Ferrier and Beetschen 1973), opening up new avenues of research and increasing the demand for the species. Additionally, the animal is coveted by the pet trade, zoos, and museums. During a study period of 31 March to 6 June 1975, 360 newts were declared for export at Bangkok's Don Muang Airport (Duplaix and King 1975). The total trade volume during that period was no doubt greater.

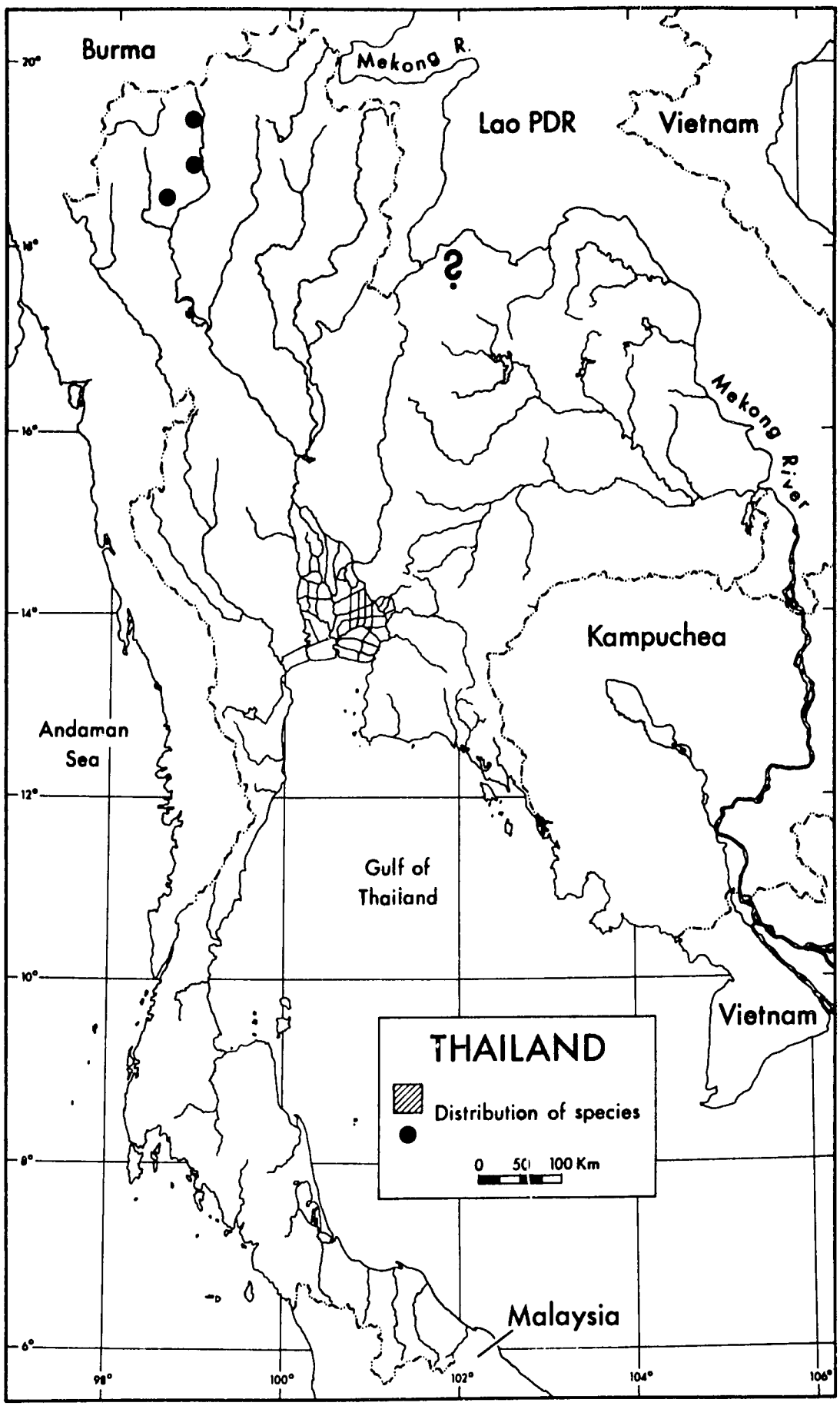
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The eggs are some 6-10 mm in diameter when deposited. The young are about 11 mm long upon emerging and grow to 52 mm or more before they lose their gills and transform into the adult form at the end of the wet season. Adults grow to a snout-vent length of approximately 70 mm. A captive specimen in the Cincinnati Zoo lived over five years (Taylor 1962, Gyi 1969, Bowler 1977).

Key Behaviors: Early in the summer months adults make local migrations to breeding ponds, where they breed and spawn throughout the rainy season. The mating behavior has been observed in captivity and in the wild and is described by Noble (1954): "The male creeps up under the female and seizes her front legs from behind, with his front legs. The 'piggy-back ride' which follows finally results in the emission of the spermatophore by the male and its being secured by the female." Late in the wet season many young are lost because of drying of breeding ponds. Early in the dry season adults and young of the year make local migrations to more permanent bodies of water. Adults come to the surface for air, but can remain motionless underwater for extended periods. Producing turbulence by stirring the water will bring the adults to the surface, dazed. This is a method people use in capturing them. They are sluggish and easily captured when the water is cold (Noble 1954, Taylor 1962, Gyi 1969).

Conservation Measures Taken: In Thailand the known areas of occurrence of *T. verrucosus* are protected in Doi Inthanon National Park and Doi Chiang Dao Wildlife Sanctuary. There are no specific Thai laws protecting this animal.

Conservation Measures Proposed: Biologists studying the mountains of northern Thailand should look for this species to determine its true range. Protection of *Tylototriton* in Doi Inthanon and Doi Chiang Dao should be maintained. IUCN (1979) recommended that the habitat of this species in Thailand be identified and brought under protection. We applaud the efforts of Dr. Khin Mg Gyi to increase our knowledge of this species and to develop it as a dissection animal, removing the need to import expensive salamanders from Europe and the United States. We caution zoologists in Southeast Asia against overexploitation for scientific/teaching purposes. The superabundant leopard frog, *Rana pipiens*, has been locally extirpated in the United States by collectors for biological supply houses. Since this newt is known to occur only in a few, isolated places, harvest should not exceed sustainable yield, and population studies will be needed to determine acceptable harvest levels. Collection and export should be monitored and controlled. To the extent possible, educators should stress the natural role of these unique amphibians (as in eating mosquito larvae) and discourage their destruction because of susperstitious beliefs.



Tylototriton verrucosus

Spine-breasted giant frog

Rana fasciculispina Inger 1970

Amphibia, Anura, Ranidae

Status: Threatened.
IUCN (1979): Threatened.

Population Size and Trend: Unknown.

Distribution and History of Distribution: This species was discovered in 1961 by Mr. Boonak at Khao Soi Dao in Changwat Chanthaburi. Additional populations may occur in Thailand and Lao PDR in mountain streams (Inger 1970) and in Kampuchea. Although IUCN (1979) classified this animal as threatened, Inger (personal communication) writes that while it is rare in collections it "is apparently reasonably abundant . . . along forested mountain streams in southeastern Thailand . . . [and] not . . . threatened any more than a large array of forest species." This species is separated from its closest living relative, R. verrucospina at Bach Ma, Vietnam, by some 700 km (Inger 1970).

Geographical Status: R. fasciculispina, as far as is currently known, is endemic to Thailand.

Habitat Requirements and Habitat Trend: This species is found in swift, forested mountain streams (Inger 1970, personal communication). Montane forest is currently being lost at an alarming rate over much of Thailand.

Vulnerability of Species and Habitat: The large size of R. fasciculispina makes it quite conspicuous to man. The montane streams it requires are easily modified by many human activities, notably agriculture and forestry practices.

Causes of Threat: Other giant Rana are actively sought as food in Thailand. The degree of human exploitation of this species is unknown. Habitat destruction probably also threatens the species.

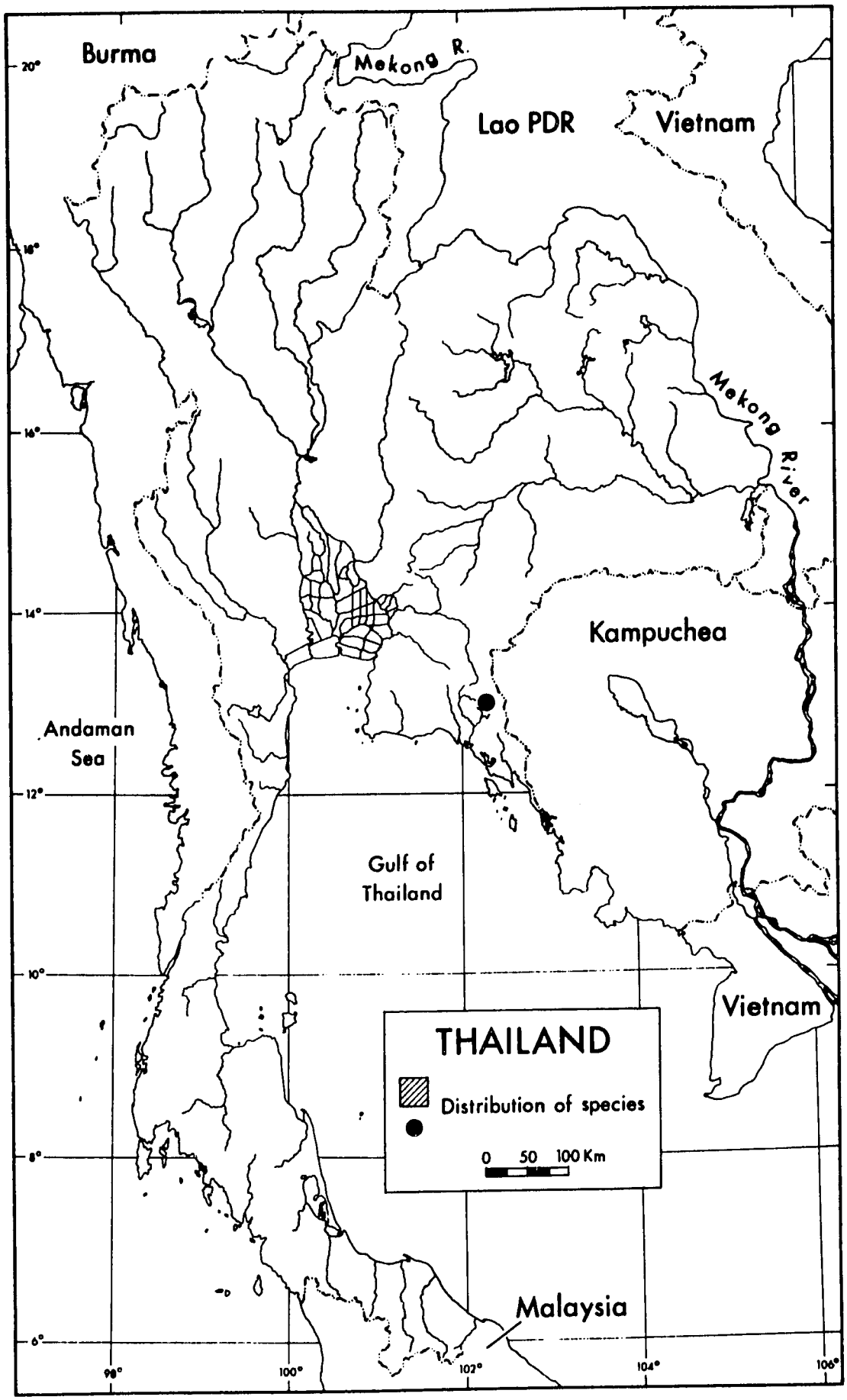
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The paratype, an adult female collected in July, contained a few enlarged, unpigmented ova. Adults reach a snout-vent length of about 105 mm.

Key Behaviors: This *Rana* apparently lays its eggs under large rocks in swift streams (Inger 1970).

Conservation Measures Taken: Khao Soi Dao Wildlife Sanctuary protects essential habitat for this species.

Conservation Measures Proposed: The protection of this animal in Khao Soi Dao should be maintained. Biologists studying montane streams in Thailand should look for this species to help determine its true range. In areas where harvest by man appears to threaten it, management plans should be instituted.



Rana fasciculispina

Tao pulu, tao pulu neua, Chinese big-headed turtle

Platysternon megacephalum Gray 1831

Reptilia, Testudines, Platysternidae

Status: Threatened.
IUCN (1968): Threatened.

Population Size and Trend: The total population size of this widespread turtle is unknown. There has been a recent decline. The species is now believed to be threatened with extinction (IUCN 1968).

Distribution and History of Distribution: This species is widely distributed along streams in the mountains of northern Thailand. Wirot (1979) believes that the population in Changwat Loei, Changwat Phetchabun, and Changwat Sakon Nakhon is a separate subspecies (P. m. peguense) from the population in northwest Thailand (P. m. megacephalum). The species is also known from southern China, Lao PDR, Burma, Taiwan, Vietnam, Hong Kong, and Hainan (Smith 1931, Taylor and Elbel 1958, Taylor 1970, Wirot 1979).

Geographical Status: P. megacephalum is widespread in the mountains of Southeast Asia and southern China. The Thai population is peripheral, lying at the southern limits of the species' overall range.

Habitat Requirements and Habitat Trend: This carnivorous, semi-aquatic turtle prefers remote mountain streams. It eats primarily small fish, mollusks, shrimp, and crabs, but is known to eat vegetation on occasion (Smith 1931, Wirot 1979). Unlike most turtles, it readily climbs trees, shrubs, and rocks near streams in search of food and basking sites.

Vulnerability of Species and Habitat: The unusual morphology of this species, with its large head, long neck, relatively flat carapace, and long, clawed, nonretractile climbing limbs make it an attractive acqusition for aquarists and scientific collectors. Moreover, among the people of Southeast Asia its flesh is thought to impart the same aphrodisiac properties as rhino horn, resulting in much collection for "medicine." Large Platysternon cost over US $30 on the Hong Kong market (H.W. Campbell personal communication). The flesh is eaten in Thailand.

Causes of Threat: The observed decline is probably due primarily to collecting by humans. The destruction of montane forest habitat probably has compounded the problem.

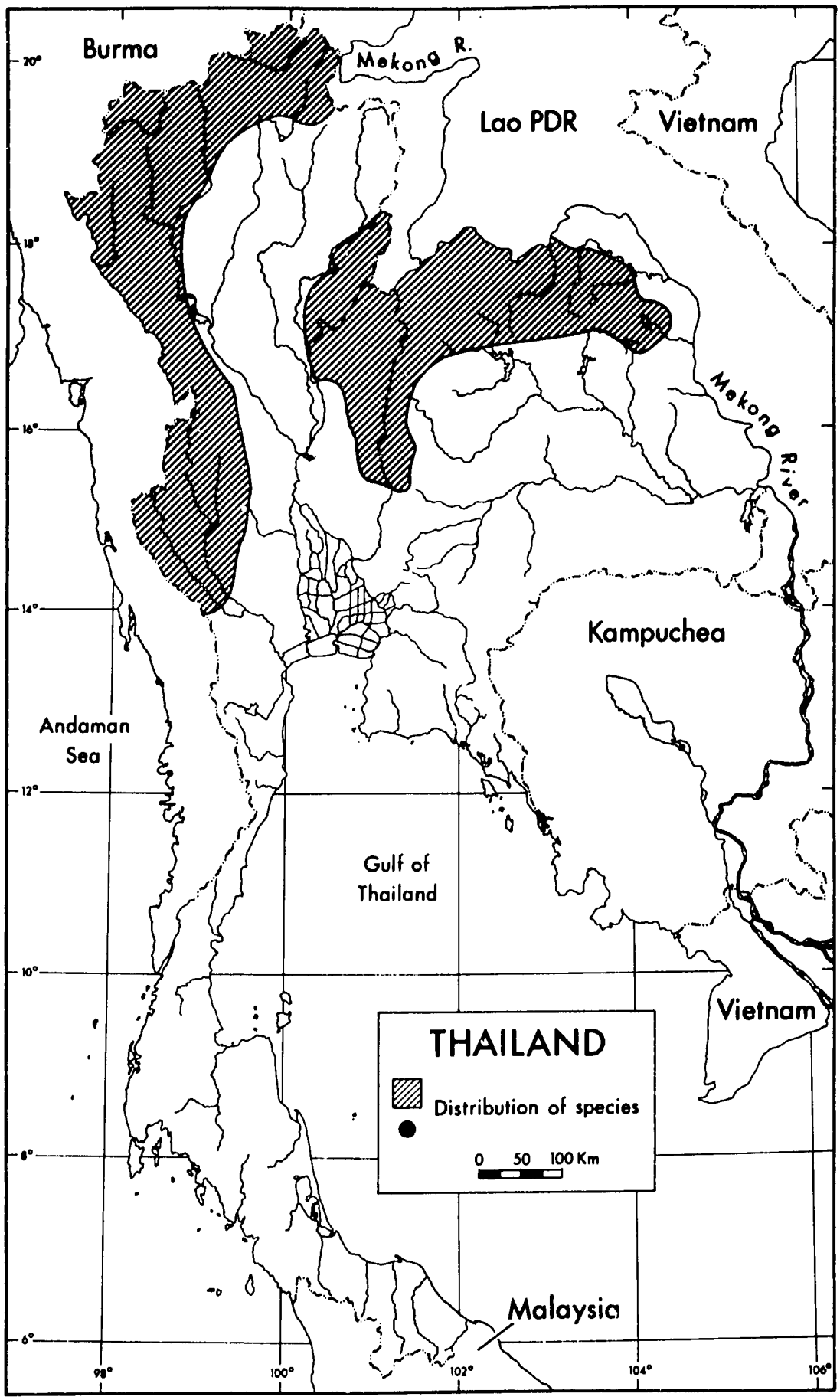
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The breeding rate in the wild is unknown. The average clutch size is small, numbering two to four eggs (Wirot 1979). Adults grow to about 20 cm (carapace length) and weigh about 0.5 kg (Wirot 1979).

Key Behaviors: This species is said to be very aggressive. With its long neck and large, powerful mouth it can inflict painful bites on man. It has well developed scent glands in the axillary and anal areas. These are probably used in social behavior, but their exact function is unknown. Its climbing behavior probably provides access to food and basking sites that otherwise would be unavailable to it. Captives at the zoo in Chiang Mai often escape by climbing out of high wire enclosures (Smith 1931, Taylor 1970, Wirot 1979).

Conservation Measures Taken: Many of the National Parks and Wildlife Sanctuaries in northern Thailand protect suitable habitat for *P. megacephalum*. Specimens are known from Phu Kradeung (1525 m) in Changwat Loei, an area included in Phu Kradeung National Park. *P. megacephlum* is also known from Sai Yok in Changwat Kanchanaburi, where the threatened bat *Craseonycteris thonglongyai* lives. We know of no laws in Thailand that specifically protect the Chinese big-headed turtle.

Conservation Measures Proposed: All of the montane National Parks and Wildlife Sanctuaries within the species' range in Thailand should be surveyed to determine the status of *P. megacephalum* in each. In areas where it is found, conservation authorities should be aware of its presence and its protection should be maintained. Where the species occurs stream habitats should be preserved with intact bank vegetation. Trade in this species should be monitored and controlled. The public should be educated that there is no scientific basis for the claim that *Platysternon* products are aphrodisiacs.



Platysternon megacephalum

Tao kra arn, tao charn, tuntong, saltwater terrapin, river terrapin

Batagur baska (Gray 1831)

Reptilia, Testudines, Emydidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN (1979): Threatened.
IUCN Red Data Book (1978): Endangered.
IUCN (1968): Threatened.

Population Size and Trend: The species has declined throughout its range. The population in Burma was thought to be near extinction in 1911 (Maxwell 1911). The largest remaining population rangewide, along the Parak River, Malaysia, has declined from 5700-8100 to 400-1200 nesting females from about 1940 to 1976 (E.O. Moll personal communication). The pre-1940 egg production of 375,000-525,000 eggs has dropped to 20,000-30,000 (Khan 1964, Siow and Moll 1981). The species is in immediate danger danger of becoming extirpated from Thailand (Wirot 1979). A reward posted for live terrapins at Thale Luang in 1979 yielded only 8 small animals (our observations), showing that the population in that heavily fished lake is nearly gone.

Distribution and History of Distribution: B. baska ranges from Bengal in India through Burma, Thailand, and Malaysia to Sumatra. They were once quite abundant in India. The only large nesting colony that remains is in the Perak River of Malaysia. In Thailand B. baska is known from populations in Thale Sap and Thale Luang near Patthalung, from Amphur Ranote in Changwat Songkhla, and from the mouths of rivers in Changwat Ranong. Wirot (1979) considers the latter population to represent a discrete subspecies, B. b. ranongensis (Smith 1931, Balasingam and Khan 1969, Taylor 1970, IUCN Red Data Book 1978, Wirot 1979, Moll personal communication). The population at Thale Luang nests on three short beaches on the western shore, the largest being near Pak Payoon.

Geographical Status: The Thai population is centrally located in the species' overall range.

Habitat Requirements and Habitat Trend: Most Batagur populations live in the brackish water of estuaries and tidal rivers. A few occupy freshwater lakes or freshwater portions of rivers. For nesting, the species requires sand beaches or islands that remain above water after monsoon floods recede. In the Perak River, Malaysia, where no suitable nesting habitat occurs near the estuary, females migrate 80-100 km upstream

to nest (E.O. Moll personal communication). The major food is riverbank vegetation. Stems, leaves, and fruits are eaten, but the dominant item in the diet is fruit of Sonneratia mangroves, and fish, molluscs, and crustaceans provide occasional dietary supplements (Moll 1978). However, young Batagur prefer fish as food (Sawat Boonthai). Adults move upriver as far as 13 km on the incoming tide to forage along the banks of tributaries, going back downstream with the ebb tide (Moll 1978). No clear habitat trend is evident, but E. O. Moll (personal communication) has noted habitat degradation from silt deposited from upstream mining and channel dredging, loss of mangrove vegetation, beach erosion, and dams and barrages that prevent use of essential terrapin habitat.

Vulnerability of Species and Habitat: Because Batagur congregate at a few traditional nesting sites and announce their arrival by sounds made while compacting the sand over the nests, they are highly vulnerable. Their estuarine habitat is highly vulnerable to local and offsite impacts, such as clearing of mangroves and introduction of silt and pesticides upstream.

Cause of Threat: The precarious status of Batagur is a direct result of overharvest of eggs and meat, without regard for the limits of this self-renewing resource. The eggs are considered to taste better than those of sea turtles and to have aphrodisiac properties. They sell for 2-3 times the price of poultry or sea turtle eggs (Moll personal communication). Batagur populations on the verge of extirpation are still heavily exploited.

Responses to Habitat Modification: Unknown.

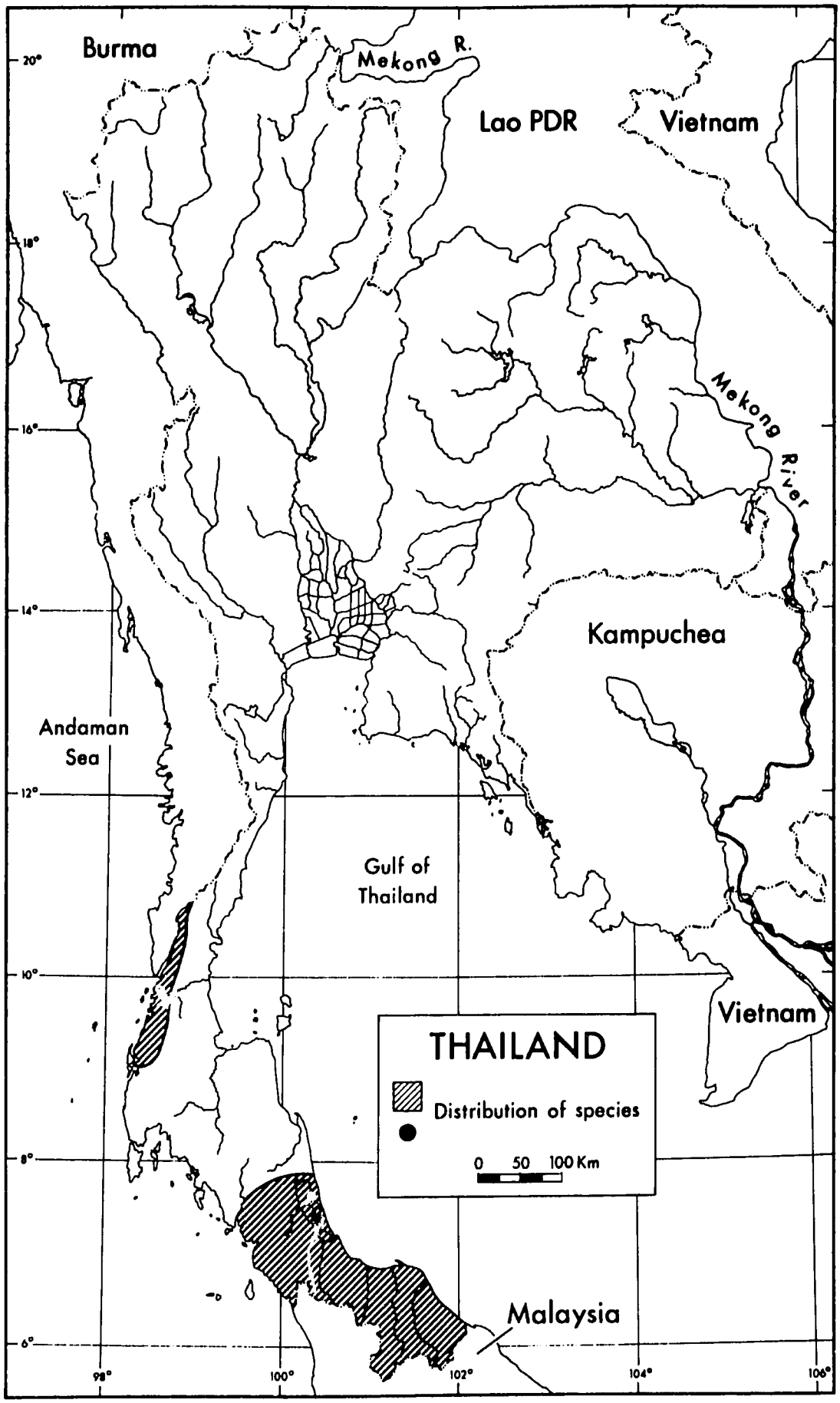
Demographic Characteristics: Females become sexually mature when they reach a carapace length of 430 mm. Clutches range from 5 to 38 eggs, averaging 26 (E.O. Moll personal communication). In the Perak River and in Thailand breeding occurs from November to early March. Over a 6-week period a female is reputed to lay 3 clutches of eggs (Maxwell 1911), which would total 50-90 eggs. The young hatch in 71-84 days and emerge from the sand about 88 days after egg-laying (E.O. Moll personal communication). Natural mortality from the time eggs are laid until hatchlings enter the water may be on the order of 90 percent. By contrast, hatching success in the Game Department hatchery in Malaysia has ranged from 13 to 76 percent (Balasingam and Khan 1969, E.O. Moll personal communication).

Key Behaviors: At the beginning of the nesting season, Batagur congregate in herds that originally numbered thousands of individuals. At night the females dig holes about 0.6 m deep in sand to lay their

eggs. After the eggs are covered with sand, the terrapins repeatedly drop their 20 kg shells on the surface to compact the sand; the resulting drumming sound from a nesting group travels far along the coast. Females typically move a short distance from the nest and dig a false nest that may reduce the effectiveness of nest predators. Terrapins on land are difficult to approach without alarming them (Moll 1978).

Conservation Measures Taken: Because of foresighted effort to preserve the last individuals of the *Batagur* population at Thale Luang, 12 adults and 6 young are in captivity at the Brackish Water Fisheries Research Station at Songkhla (our observation). Facilities in which these could breed are not available. The Game Department and state governments in Malaysia conduct research and operate several hatcheries that ensure recruitment of hatchlings into several populations (E.O. Moll personal communication).

Conservation Measures Proposed: The habitat of the remaining Thai populations needs to be identified and portions of it should be protected (IUCN 1979). The entire turtle egg industry in Southeast Asia needs to be reorganized with due attention to sustained yield (IUCN Red Data Book 1978). If properly managed, *B. baska* could constitute a valuable renewable source of very palatable animal food for Thailand. E.O. Moll (personal communication) estimated that commerce in eggs of the depleted *Batagur* population at the Perak River, Malaysia, now is US$ 2500 per year and could reach 10-15 times that amount if the population could achieve its former abundance. The captive animals at Songkhla represent an immediate opportunity for the Thailand Fisheries Department to begin a hatchery program. Considering the extremely precarious status of the Thale Luang population, the first priority there should be to captive-rear most eggs laid in the wild and to release the hatchlings each year.



Batagur baska

Tao chak, spiny terrapin

Heosemys (Geoemyda) spinosa Bell in Gray 1830

Reptilia, Testudines, Emydidae

Status: Threatened.

Population Size and Trend: Total numbers of H. spinosa are unknown. Wirot (1979) declared it to be in danger of becoming extinct.

Distribution and History of Distribution: The spiny terrapin is known definitely from Changwat Chumphon, Changwat Ranong, Changwat Surat Thani, and Changwat Nakhon Si Thammarat, but probably occurs throughout the peninsula south of the Isthumus of Kra. It is also known from Burma, Malaysia, Borneo, and Sumatra (Smith 1931, Taylor 1970, Wirot 1979).

Geographical Status: The Thai population is peripheral, lying at the northern limits of the species' distribution.

Habitat Requirements and Habitat Trend: This species is terrestrial. It feeds on primarily on plants, such as aquatic plants and bamboo, but will also consume crabs, small frogs, molluscs, shrimp, and worms. It prefers the humid, shaded areas and takes cover in the leaf litter and grass clumps (Taylor 1970, Wirot 1979, E.O. Moll personal communication).

Vulnerability of Species and Habitat: This is a sluggish species that forages in the daytime, making it conspicuous to man. The montane streams it requires are easily modified by deforestation and erosion produced by agriculture and mining. Leaf litter and grasses, which H. spinosa uses for cover, are vulnerable to fire.

Causes of Threat: Unknown.

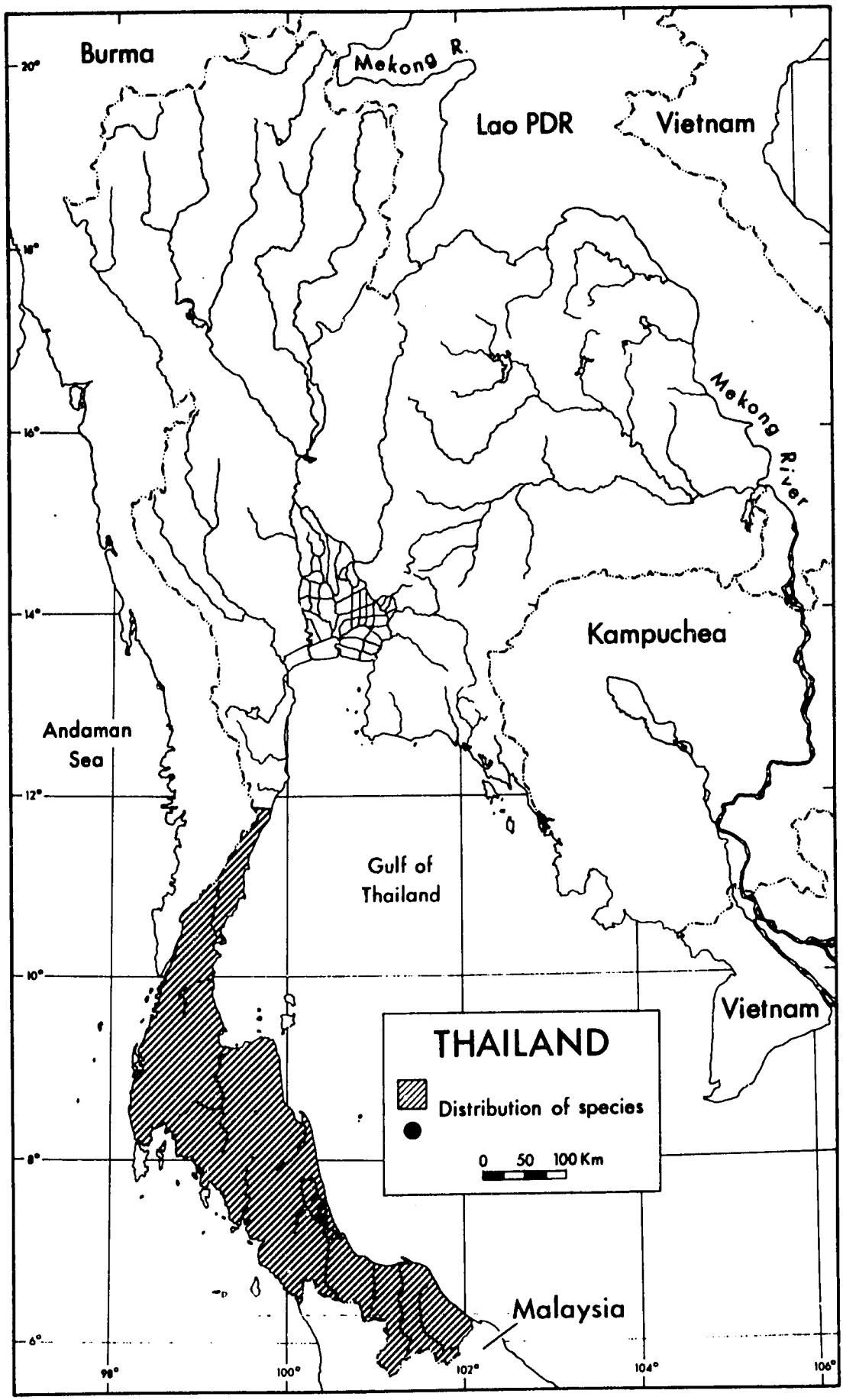
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown. This species reaches a size of about 225 mm and averages about 0.5 kg in mass (Taylor 1970, Wirot 1979).

Key Behaviors: With suitable shelter *H. spinosa* remains motionless for extended periods between foraging bouts. This probably alleviates some of the predation pressure.

Conservation Measures Taken: None.

Conservation Measures Proposed: The locations of spiny terrapin populations need to be identified so that forestry and watershed management plans can consider the needs of this species. The effects of different burning regimes on *H. spinosa* ground cover need to be considered, as do the effects of other habitat alterations. The unusual spiny shell of this terrapin could potentially make it vulnerable to the live animal trade, and it should be looked for in shipments of reptiles. If it is overexploited by hunting, measures should be instituted to conserve it on a sustained yield basis.



Heosemys (Geoemyda) spinosa

Tao hok luang, six-legged tortoise, yellow giant tortoise, Chinese land tortoise

Testudo (Geochelone) emys Schlegel and Müller in Temminck 1844

Reptilia, Testudines, Testudinidae

Status: Threatened.
CITES (1979): Appendix II.
IUCN (1968): Threatened.

Population Size and Trend: The total population size is unknown. Once common and widely distributed in peninsular Thailand, these tortoises "are now becoming rare" (Taylor 1970).

Distribution and History of Distribution: In Thailand this form is known definitely from Changwat Nakhon Si Thammarat and Changwat Ranong, but probably occurs throughout the peninsula in montane habitat. It is also known from India (Assam), Burma, Malaysia, Sumatra, and some smaller islands of the Indo-Australian Archipelago (Smith 1931, Taylor 1970, Wirot 1979). Smith (1931) believed that T. emys purchased in markets in Saigon and Canton and one captured at the mouth of the Yang-Tse Kiang were human imports.

Geographical Status: The Thai population is centrally located in the species' overall range.

Habitat Requirements and Habitat Trend: This species prefers hill and mountain country. Unlike most members of the Testudinidae, it is fond of water. It is primarily herbivorous, eating aquatic vegetation, bamboo, and the like, but will also eat worms, shrimp, craps, molluscs, and small frogs (Smith 1931, Taylor 1970, Wirot 1979).

Vulnerability of Species and Habitat: T. emys os the largest Asiatic Testudo, averaging some 31 kg. Its flesh is eaten throughout its range in Thailand. The slow, plodding gait coupled with its large size makes T. emys quite visible and vulnerable to human hunters. Small individuals sell for U.S. $6 in the Bangkok weekend market (our observation). Because the remote country it occupies is now being rapidly settled by humans, harvest rate and coverage are increasing. Habitat disturbance brought on by human settlement also may be an important problem (Smith 1931, Taylor 1970, Wirot 1979).

Causes of Threat: Hunting for human food has apparently decimated this large tortoise. The effects of the extensive human settlement of upland areas in the past several decades are probably great, but are unknown. Over 1600 live T. emys were exported from Thailand to the United States in 1978 (Mack 1977). This number dropped to 27 in 1980 (TRAFFIC 1981).

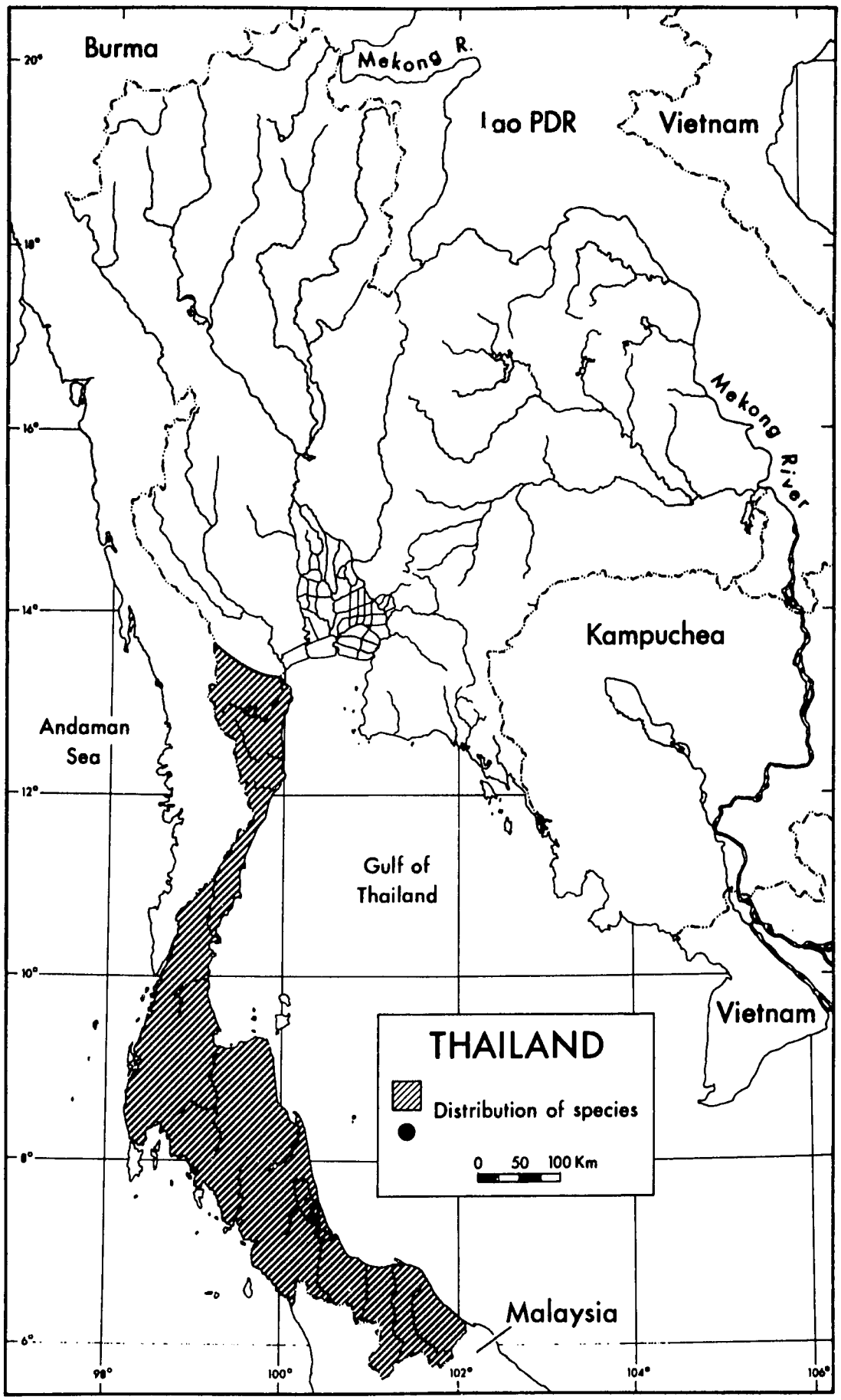
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The breeding rate of *T. emys* in the wild is apparently unknown. Wirot (1979) gave the average clutch size as 5-8 eggs. Adults of this large species are known to have reached a carapace length of 470 mm (Taylor 1970).

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: Strict protective laws are needed to prevent extirpation by overexploitation (IUCN 1968). Its habitat must be identified and protected (IUCN 1979). Research on its basic biology is needed to help conserve the Thai population and to manage it as a renewable source of human food.



Testudo (Geochelone) emys

Families Cheloniidae and Dermochelyidae - The Sea Turtles

Introductory Comments

The Exploitation of Sea Turtles by Man

Five species of sea turtles are known from Thai waters--the leatherback, Dermochelys coriacea; the green turtle, Chelonia mydas; the olive or Pacific ridley, Lepidochelys olivacea; the hawksbill, Eretmochelys imbricata; and the loggerhead, Caretta caretta. Although widespread, all five are endangered by overexploitation and habitat modification by man. Each deserves the ongoing attention of conservation authorities. These turtles formed an important part of the subsistence of many indigenous peoples, including in Thailand the "sea nomads" or "sea gypsies" (in Thai, "Chaaw Ta Le") of the tribes Moklen, Urak Lawoi', and Moken (Polunin 1975, Polunin and Sumertha Nuitja 1979). All five species are actively hunted for their eggs, meat, and shell in Thailand today (Lekagul 1977). The current production of sea turtle products in Thailand is high (Polunin and Sumertha Nuitja 1979).

Though all five species here considered are strictly protected under Appendix I of CITES (1979), many Convention nations are still actively involved in the trade. The United States was once a leading importer of sea turtle products, but a new law in 1978 prohibited all further imports of sea turtle products (Mack et al. 1979).

Thailand is among the world's leading exporters of raw tortoise-shell, mainly a product of the hawksbill. ("Tortoise-shell" is a misnomer, for sea turtles are not tortoises.) Shell production is certainly higher than it used to be (Polunin and Sumertha Nuitja 1979). Historically tortoise-shell was an important trade item in the region. The Chinese have traded in it for at least 2000 years. It is made into jewelry and utensils. Whole shells are sometimes used as wall ornaments. Some importing countries pay more for hawksbill shell than for an equivalent weight of elephant ivory. Shell is available in the markets in Hat Yai, Phuket, and Bangkok (Polunin 1975). As shells get rarer they command higher prices. A hawksbill shell brings up to US $150-200, Chelonia up to US $100 or more, Caretta and Lepidochelys fetch US $5-10, and Dermochelys shell has little economic value in Thailand (Lekagul 1977). For the period 1976-78, four of the five leading exporters of tortoise-shell were in the region: Indonesia, India, the Philippines, and Thailand itself. The total world export volume of raw shell increased from 250,000 kg in 1976 to over 390,000 kg in 1978. The latter figure probably represents between 100,000 and 500,000 hawksbills. Thailand's exports of raw tortoise-shell have increased dramatically since the early 1970's: 14,500 kg (1973), 14,522 kg (1974), 10,611 kg (1975), 23,859 kg (1976), 37,941 kg (1977), and 53,618 kg (1978). The major destinations of Thai shell are Hong Kong, Taiwan, and Singapore (Mack et al. 1979).

With increased tourism there has been an increased demand for the dried, stuffed, and varnished juvenile and adult sea turtles sold as curios. These are commonly seen for sale in markets. Juveniles are sometimes preserved whole in clear plastic paper weights (Ehrenfeld 1979). The leather, primarily from the flippers, is used to make handbags, shoes, and other items. There is a minor trade in live animals.

Sea turtles are an important, potentially renewable source of human food. The flesh of all five species is eaten in Thailand, especially the olive ridley and the green. The latter is the green turtle of soup fame. Taboos against eating turtles in the Islamic communities of south Thailand are generally ignored, as are the sections of the Fisheries Act of B.E. 2490 (1947) that prohibit hunting of C. mydas, E. imbricata, and C. caretta. The meat of a single large turtle is worth about US $50 (Polunin 1975). Oil, primarily from the green, is used in the manufacture of cosmetics. In some areas the cartilage of the green ("calipee") is used to make a clear soup (Ehrenfeld 1979). The eggs of all five species are eaten (Polunin 1975, Lekagul 1977). The Thais call the eggs "Kai-ja-la-met" or "Kai-tao-thale" (Phasuk and Rongmuangsart 1973). They have a nutritional value similar to fowl eggs, but are higher in protein (IUCN 1971). The eggs of Lepidochelys cost US $.075-.09 (Lekagul 1977). Polunin (1975) estimated the total annual Thai egg yield to be about 400,000 eggs.

Nesting Beaches in Thailand

On the world level none of the Thai nesting beaches can now be considered to be of major significance. All five species have been reported from certain beaches in the region, but there is a tendency for different species to prefer different beaches. Data on population sizes and trends are scanty and often of questionable reliability (Polunin 1975, Polunin and Sumertha Nuitja 1979).

In the Gulf of Thailand the major nesting beaches are on Ko Kram in Changwat Chon Buri, a continental island under the control of the Royal Thai Navy. Penyapol (1957) gave the ratio of 4 greens:1 hawksbill for nesting turtles at Ko Kram and stated that nesting occurs all year in the Gulf, but most nesting takes place from March to September, with a peak in June. Polunin (1977) visited the island briefly in July of 1974 and gathered information on the status of nesting turtles. Egg yields at Ko Kram dropped from about 185,000 in 1963-1965 to 50,850 in 1972-1973 (average annual totals). Polunin saw intense nesting at Hat Kham and Hat Nuan on the southeast side of the island and was told that Hat Chek (southeast) and the southwest facing beaches Hat Krathing and Hat Sadao were being used also. Beaches facing north and northeast were less used. The tiny, isolated island of Ko Kra east of Changwat Nakhon Si Thammarat is now a minor nesting area. Penyapol (1957) gave a ratio of 5 greens: 3 hawkbills for that island. The present extent of nesting is unknown,

but Polunin (1975) estimated the annual egg yield at 10,000 eggs. The Ko Kut/Ko Chang group in Changwat Trat is a minor nesting area. Polunin (1975) estimated the annual egg yield from this group to be 20,000 eggs. Suitable beaches in Changwat Pattani are still used as nesting areas. Polunin's estimate of annual egg yield (1975) there was 30,000.

The major nesting areas on the west coast were given by Polunin (1975) as Phangnga, Phuket, the Similan Islands, the Surin Islands, and the Ko Adang group. For the last of these, Polunin estimated annual egg yield at 80,000. The entire group, now protected in Tarutao Marine National Park, had only 2 or 3 turtles reported to come ashore in the 1979-1980 nesting season (November to March). It has evidently experienced a dramatic and rapid decline (Boonruang Saisorn, personal communication). Polunin (1975) estimated that the beaches of Changwat Phuket yield 10,000 eggs annually. For the coasts of Changwat Phangnga he estimated 60,000 eggs annually, mainly from the districts of Churaburi, Thai Muang, and Takuatung. For the Surin Islands and the Similan Islands, lesser sea turtle areas, he estimated an annual yield of 20,000 eggs each. The most abundant sea turtles along the west coast are the green and olive ridley.

Sea Turtle Life History

Almost without exception male sea turtles do not come ashore. Females leave the water only to lay eggs. Marine turtles do not reach sexual maturity until about 10 years of age. If undistrubed by man, reproductive individuals may reach impressive ages, perhaps as old as 80 years. After mating, females can store viable sperm in their oviducts for up to a year. A female may come ashore to lay several times during a nesting season, but not necessarily every year. Dark nights with strong winds and high waves seem to be preferred. At high tide she crawls up onto the sandy beach with her front flippers and selects a spot up to 100 m beyond the high tide line. Contact with saltwater would kill the eggs. If the sand is too dry to support the walls of a hole she will seek moister sand. Proper nesting sand, then, must be above the level of liquid seawater, but must not be completely dry. If disturbed before laying, the female will return to the water, but once oviposition commences sea turtles seem to be oblivious to disturbance. After spending about two hours excavating the hole she lays the eggs (50-250) in about a half hour, covers them, and returns to the sea exhausted (Smith 1931, Phasuk and Rongmuangsart 1973, Ehrenfeld 1979, Wirot 1979).

The eggs are not sensitive to handling during the first few days, and that is the best time to move them if necessary for conservation efforts. Incubation is about 2 months. Incubation temperature can affect the sex of the hatchlings. The young of a batch hatch synchronously and require several days to cooperatively dig out. A single hatchling would be unable to reach the surface. When the topmost hatchlings are within a few inches of the surface they become quiescent until the surface

temperature falls below a certain level (at night or on a cool, rainy day). Then they burst out explosively and run for the sea. Mortality at this phase is high--many avian, terrestrial, and fish predators captilize on turtle emergences. The small hatchlings (30-60 g) and adult females are both thought to locate the water by heading for the brightest horizon. In settled areas many young are fatally attracted inland by electric lights. Hatchlings are inept at controlling their buoyancy and float around on the surface for a time, adding to their vulnerability. Fewer than 10 percent survive the fatal first year (Smith 1931, Ehrenfeld 1979, Wirot 1979).

Adults feed on animals, especially invertebrates like sponges, marine worms, and molluscs. The green turtle also consumes sea grasses (angiosperms) and other plant matter. All sea turtles except leatherbacks (jellyfish specialists) prefer meat in captivity. All are air breathers, of course, and must stay near the surface when active. When quiescent they can remain underwater for hours. Some wedge their bodies into cracks in the bottom to sleep submerged, but many prefer to sleep and bask afloat, where they are quite vulnerable to human predation. The only other significant enemies of adult sea turtles are large sharks. The adults are famous for their long distance migrations between feeding grounds and nesting beaches, but the movements of the Thai populations are virtually unknown. It has been estimated that there are fewer than 1000 adult female sea turtles of all species surviving in Thai waters (Smith 1931, Polunin 1975, Ehrenfeld 1979).

Since this account was drafted, an entire issue of the American zoologist (Volume 20 Number 3) has been published on behavioral and reproductive biology of sea turtles.

Causes of Threat

"In this century no major population of any species of sea turtle has been proved to increase its numbers significantly, either spontaneously or as the result of a conservation effort" (Ehrenfeld 1979). The single possible exception is the turtles nesting on the beaches near Tortuguero, Costa Rica. In Thailand all five species have declined in the last ten years and all are threatened with extirpation from Thai waters (Lekagul 1977, Lekagul and Damman 1977). Even though sea turtle populations have been seriously depleted, the levels of exploitation are at an all time high and are increasing. As the animals become rarer, their products command higher and higher prices, aggravating the situation (Lekagul and Damman 1977). The two major threats are direct human predation (Polunin 1975) and the accidental drowning of turtles in trawler nets (Boonruang Saisorn personal communication).

Overexploitation of turtle egg resources directly reduces their numbers (Lekagul and Damman 1977). The existing Thai nesting beaches obviously

once supported a far greater population of turtles than they do now. In Changwat Phangnga and Changwat Phuket local government revenue from the rental of nesting beaches has fallen. Supervision of nesting beaches, especially of hatchling release, is poor except in a few areas. Beach concessionaires do not consistently report egg yields and hatchling releases as they are supposed to. Since 1965 probably fewer than 20,000 hatchlings per year have been released (Polunin 1975). The decline indicated by egg yield data from Phangnga and Ko Kram is statistically significant ($P<.05$, Spearman rank correlation, Polunin and Sumertha Nuitja 1979). In Thailand today the young and eggs are taken from virtually every nesting beach and the miniscule number of young that join the adult population is insufficient to maintain sustained yields (Lekagul 1977, Polunin 1977).

Adults are actively hunted on the beaches and in the water. The expansion of tourism and of the human population in general has led to an increase in the killing of adult sea turtles. Curios, meat, eggs, and shell are still to be found regularly in Thai markets, especially the Sunday Market in Bangkok (Polunin 1975, 1977). The "sea nomads" of the Moken tribe have a special spear, the "poleng-ba-penyui," that they use to kill sea turtles and crocodiles. They continue to hunt sea turtles. Such subsistence level hunting by indigenous peoples did not threaten the animals historically, but its effects on reduced populations can be devastating (Polunin 1975, Ehrenfeld 1979).

In addition to intentional harvest, many sea turtles are killed incidentally by fishing activities. "Purse seines" and "otter boards" kill many (Lekagul 1977). Trawler activity in the Gulf of Thailand has increased dramatically in recent years. The catch of fish per unit of effort is falling. The verbal evidence indicates widespread killing of adult sea turtles around Thai coasts, with some trawlers reporting as many as 20 turtles killed per boat per year. Most trawler captures are in the Ko Kut/Ko Chang group, Ko Kram and vicinity, Ko Samui, and off Changwat Ranong. Also, the bamboo stake traps set inshore in the Gulf often kill turtles (Polunin 1975, 1977).

Indirect effects of habitat modification by man also threaten the turtles. At Ko Kra, the tiny islet off Nakhon Si Thammarat, much of the beach has been rendered unusable because coral rubble has been deposited on the beach as a result of fishing with dynamite in the reef offshore. Land development along beaches can lead to erosion and usually makes beaches unsuitable for nesting (Lekagul and Damman 1977, Polunin and Sumertha Nuitja 1979). The beach at Pattaya has suffered such a fate. The important nesting island of Ko Kram in Changwat Chon Buri may be affected by a new jetty constructed on the mainland nearby. In six turtle nesting attempts observed there, eggs were laid in only one (Polunin 1977). This may have been due to the new jetty. Its powerful floodlights illuminate several of the island's beaches. Large ships use the new facility. Loud noises and bright lights are known to interfere with turtle nesting (Lekagul and Damman 1977). Additionally, the effects of increased silt loads in coastal waters from mining and water pollution in general on sea turtles need to be studied.

Conservation Measures Taken

Historically the Buddhist monks in Thailand hatched and released sea turtles. This practice endured at Ko Kram until quite recently (Polunin 1975). The major modern Thai conservation efforts include the sections of the Fisheries Act of B.E. 2490 (1947) that give legal protection to adult Caretta, Chelonia, and Eretmochelys; the areas protected as reserves by the Royal Thai Navy, the National Park Act of B.E. 2504 (1961), and similar legislation; and the plans for nesting beach concessions and hatchling releases administered by certain Changwat governments. Research on sea turtle biology has been conducted at the Phuket Marine Biological Center and elsewhere. Thailand's Queen has taken a personal interest in sea turtle conservation and has donated an island (Mun Nai) for this purpose.

The availability of products made from the three species protected by the Fisheries Act attests to the fact that it is generally ignored and is ineffective in conserving these reptiles.

The Royal Thai Navy controls the important nesting beaches at Ko Kram from the naval station at Sattahip in Changwat Chon Buri. With the cooperation of Admiral Jing Jullasukhum the Navy has strictly reserved a beach on Ko Kram for turtle hatching (Lekagul 1977). A small amount of captive rearing has been carried out at Sattahip (Polunin 1975).

The reserves with significant potential as nesting areas are the proposed Ang Thong National Park, the proposed Ko Surin Wildlife Sanctuary, and the existing Tarutao Marine National Park. The enforcement staff at the latter is spread thinly over 51 islands and cannot circumvent poaching (Boonruang Saisorn personal communication). Though considered an important nesting area in the early 1970's Tarutao, as has been mentioned, has suffered a serious decline in nesting turtles in recent years.

At the Changwat level many, but not all, beaches are rented out to individuals under contract on a yearly basis. The contracts stipulate that a certain percentage (often 10 percent) of the eggs must be hatched and released. In some coastal Changwat there are strict laws dealing with turtle releases. Polunin (1975) stated that "for failure to release the hatchlings the fines are: bht. 15,000 in northwest Phuket, bht. 5,000 in southwest Phuket, and bht. 45,000, bht. 33,000, and bht. 39,000 in the Takuatung, Thai Muang, and Churaburi districts of Pha Nga Province, respectively. In Pattani each concessionaire pays a deposit of bht. 7,500 which is forfeited if the hatchlings are not released." (20 Baht = US $1.) Additionally, in Changwat Phuket and Changwat Phangnga there are further fines for failing to protect rental beaches. These Changwat beach concessions are sound in theory but need to be better enforced to be effective. Presently the tens of thousands of hatchlings meant to be released each year under these schemes (Polunin 1975) are simply not being hatched.

Under a program begun in 1974, 50 percent of the eggs from certain beaches are taken to fishery stations to be hatched, reared to a size large enough to reduce predation, and released. The turtles reared in this program are mainly olive ridleys, with some loggerheads and hawksbills, and a few greens. Releases under the new program have been 1107 in 1977, 4820 in 1978, 5213 in 1979, and 3-4000 (estimate) in 1980. Another new program requires the fishermen to fill out questionaires reporting the number of nesting turtles in an area, but these data are often of questionable reliability because royalties on concessions depend on the presumed number of nesting turtles.

Two Thai researchers at Phuket, Boonlert Phasuk and Sayan Rongmuangsart, have studied the growth in captivity of Lepidochelys and the feasibility of captive sea turtle farming in Thailand. They have also tagged wild animals in the hope of learning the movements of the Thai populations (Phasuk and Rongmuangsart 1973, Polunin 1975, Polunin and Sumertha Nuitja 1979). In addition to the aforementioned rearing efforts at Sattahip and Phuket there also has been small scale turtle farming along the coast of Changwat Phangnga (Polunin 1975).

Conservation Measures Proposed

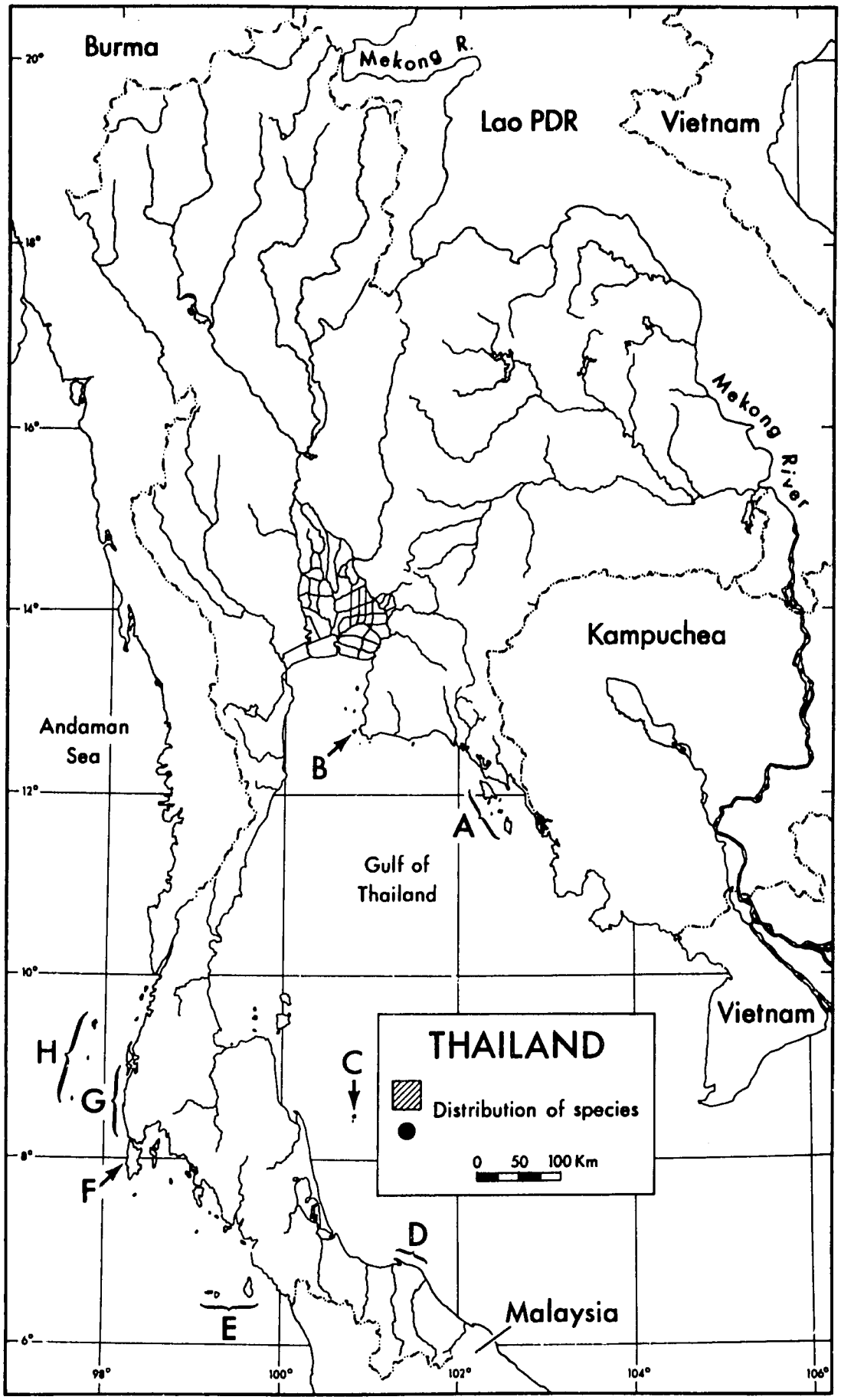
Drastic and immediate measures are needed if Thailand is going to leave viable sea turtle populations for its future generations. Improved enforcement of the relevant sections of the Fisheries Act and the National Park Act would be helpful, but cohesive new legislation on sea turtles is called for. The Thai government should consider amending the Wild Animals Reservation and Protection Act (WARPA 1972) to include all five species of sea turtles in the protected list. Several authorities have wisely suggested that a total ban on the hunting of adults and the collection and sale of eggs be implemented for 6-10 years to allow populations a chance to recover (Polunin 1975, Polunin and Sumertha Nuitja 1979). More practical solutions would include the setting of size limits on adults, seasonal closures, and better supervision of commercial nesting beaches. In any case a thorough evaluation of the current beach concession system is in order. Since any conservation plans for these wide-ranging animals must of necessity be international in scope, it is unfortunate that different Changwat governments (even different districts within a Changwat) have differing laws on this subject. Management of this resource would be more effective if it was coordinated or controlled by the central Thai government. Perhaps the concession fees and any fines could be returned to the Changwat so that this revenue would not be lost by local government. The Marine Fisheries Division should consider assuming control of sea turtle hatching and harvest. The feasibility of allowing the "Sea Nomads" to continue hunting turtles for their own use should be studied.

Improved legislation cannot be effective unless it is understood by the citizens as being in the long-term best interest of themselves and their countrymen. To promote this enlightened self-interest, it will be essential to educate the public about the problem and solutions that will sustain this renewable resource. Because the information must reach remote areas, perhaps the best approach would be a regular natural resource radio program prepared by the fishery, wildlife, and forestry experts at Kasetsart University and distributed widely to regional radio stations. Additionally it would be helpful in managing the beach concessions if the expertise of these scientists were made available through technology transfer agents (agriculture extension agents) assigned to the areas having turtle nesting beaches.

Although sea turtles in Southeast Asia were mentioned in the European literature as early as Nieuhoff (1666) and there have been a plethora of observations published since (mostly anecdotal), today we remain ignorant of many basic facets of Southeast Asian sea turtle biology. Ongoing research on Thailand's sea turtles should be supported. Current data on population sizes and exploitation by man should be collected. The factors such as artificial lights, loud noises, coastal development, and the like, that affect nesting beaches should be studied and their impacts mitigated wherever possible. Ways of avoiding trawler-turtle conflicts deserve study. Basic data on the life history and movements of the Thai populations are needed before sound management plans can be formulated. Cooperative tagging studies between Thailand and other nations in the region would be desirable. With public education, research, improved controls on exploitation, and foresight it may be possible to save this dwindling resource.

Important sea turtle beaches in Thailand.

A. Ko Kut/Ko Chang Group, Changwat Trat.
B. Ko Kram, Changwat Chon Buri.
C. Ko Kra, Changwat Nakhon Si Thammarat.
D. Changwat Pattani.
E. Tarutao National Park (Ko Adang Group), Changwat Satun.
F. Changwat Phuket.
G. Changwat Phangnga.
H. Ko Similan/Ko Surin (= Ko Sulin) Group, Changwat Phangnga and Changwat Ranong.



Important Sea Turtle Beaches

Tao ya, tao sarai ta daeng, tao sung-gasee, olive or Pacific Ridley turtle

Lepidochelys olivacea (Eschscholtz 1829)

Reptilia, Testudines, Cheloniidae

Status: Endangered.
USFWS (1980a): Threatened.
IUCN (1979) : Threatened.
CITES (1979) : Appendix I.
IUCN Red Data Book (1975): Endangered.

Population Size and Trend: Considering all Thai waters, this is the most common sea turtle, for most of the sea turtles along the west coast are olive ridleys. Worldwide there has been a precipitous drop in numbers of L. olivacea in recent years. There are now several hundred thousand females surviving in the species wide range (Ehrenfeld 1979, A.H.V. Sharma personal communication).

Distribution and History of Distribution: In Thailand it is found all along the west coast and is still a locally common breeder in a few places, such as the Laem Phan Wa reserve at Phuket Marine Biological Center. It is widely distributed in the tropical and subtropical waters of the Indo-Pacific and parts of the Atlantic (Taylor 1970, Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Polunin 1975, Ehrenfeld 1979, Wirot 1979).

Geographical Status: The Thai populations are central to the species' overall range.

Habitat Requirements and Habitat Trend: This is said to be one of the most tropical of sea turtles. It generally nests only on the beaches of continents and large islands such as Madagascar and Borneo (IUCN Red Data Book 1975). See the Introductory Comments.

Vulnerability of Species and Habitat: The flesh of this animal is considered by many to be second in flavor only to Chelonia. It is widely eaten in Southeast Asia. The flipper skin is prized as leather for shoes and handbags. Ridleys are also exploited for eggs, oil, and curios (Polunin 1975, Ehrenfeld 1979, Polunin and Sumertha Nuitja 1979).

Causes of Threat: See the Introductory Comments.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: L. olivacea may breed every year. Nests in Sri Lanka have yielded from 90 to 135 eggs. Most breeding at Phuket takes place October to February. Eggs at Phuket hatch in 50-60 days. The growth of captive hatchlings in Thailand is very slow until after the first 6 months (Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975).

Key Behaviors: Wirot (1979) reported that olive ridleys sometimes lay eggs as far as 180 m from the water.

Conservation Measures Taken: Boonlert Phasuk and Sayan Rongmuangsart at Phuket Marine Biological Center studied the food preferences and captive growth of olive ridleys purchased as hatchlings from concessionaires and raised with differing diets. They found that all ages studied preferred meat, especially molluscs, and died if raised on a strict vegetarian diet. Although their captive hatchlings showed a high (33 percent) mortality in the first six months of life, this figure is undoubtedly far lower than the mortality rate of wild hatchlings. They thus demonstrated the feasibility of raising hatchlings in captivity through the first deadly year and releasing the yearlings to supplement wild populations (Phasuk and Rongmuangsart 1973).

Conservation Measures Proposed: See the Introductory Comments.

Kra, hawksbill turtle

Eretmochelys imbricata (Linnaeus 1766)

Reptilia, Testudines, Cheloniidae

Status: Endangered.
USFWS 1980a: Endangered.
IUCN 1979 : Threatened.
CITES 1979 : Appendix I.
IUCN Red Data Book 1975: Endangered.
Thai Fisheries Act of B.E. 2490 (1947): Capture forbidden.

Population Size and Trend: This animal was once common at certain localities in Thailand. It was especially abundant at Ko Klang in the Ko Adang Group in what is now Tarutao Marine National Park. In Thailand it has recently become rare. Since it usually does not nest in large aggregations its total numbers are hard to assess, but it is certainly endangered throughout the world (Polunin 1975, Ehrenfeld 1979, A.H.V. Sharma personal communication).

Distribution and History of Distribution: The hawksbill occurs in the tropical and subtropical waters of the world. It is known from both Thai coasts. In the Gulf of Thailand it nests at Ko Kram in Changwat Chon Buri, tiny Ko Kra off Changwat Nakhon Si Thammarat, and other areas. At two islands in the Ko Kut/Ko Chang Group in Changwat Trat, Ko Rung and Ko Kra (not to be confused with the aforementioned islet off Nakhon Si Thammarat), this is the most common nesting sea turtle. On the west coast there are reports of nesting turtles from Phuket and the Ko Adang Group (Penyapol 1957, Polunin 1975, Lekagul and Damman 1977, Ehrenfeld 1979).

Geographical Status: Hawksbills are widespread in both oceans that touch Thailand.

Habitat Requirements and Habitat Trend: *Eretmochelys* nests both on islands and mainland shores and will use stretches of beach too short to be acceptable to other sea turtles. It prefers the reefs and inshore waters with hard bottoms. The young are carnivorous and prefer shrimp. Adults are mainly carnivorous, consuming fish, tunicates, coral, molluscs, crustaceans, and jellyfish, but they will take plant matter at times (Smith 1931, Deraniyagala 1939, Penyapol 1957, Phasuk and Rongmuangsast 1973, IUCN Red Data Book 1975, Ehrenfeld 1979, Wirot 1979). See the Introductory Comments.

Vulnerability of Species and Habitat: Although the meat is of an inferior grade and sometimes poisons (and rarely kills) people, these animals are relentlessly hunted for their shell, the main source of the tortoiseshell of commerce. The demand for shell is high, as are prices. The eggs are widely eaten. Stuffed *E. imbricata* curios are seen on the Bangkok and Phuket markets and sell for about US $8 per cm (Phasuk and Rongmuangsart 1973, Polunin 1975, Ehrenfeld 1979). See the Introductory Comments.

Causes of Threat: The overexploitation of this species by man is driving it to extinction.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: In the Gulf of Thailand eggs are laid all year. At Ko Kram the nesting activity is concentrated from March to September. At Ko Kra (Nakhon Si Thammarat) most breeding takes place from December to February. At Phuket nesting occurs from October to February. Incubation takes 45-60 days in Thailand. An adult female lays about 200 eggs 2-3 times per season and may not breed in alternate years. Adults commonly weigh less than 50 kg, but specimens up to 140 kg are known (Penyapol 1957, Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Ehrenfeld 1979, Wirot 1979).

Key Behaviors: When approached on land this turtle will often defend itself by biting. Deraniyagala (1939) described the nesting behavior in detail. See the Introductory Comments.

Conservation Measures Taken: Hawksbills are legally protected under the Fisheries Act, but this has not prevented their decline in Thai waters. Some have been kept in captivity at the naval station at Sattahip in Changwat Chon Buri. Rental turtle beaches have released thousands of hatchlings of this species since the early 1960's (Phasuk and Rongmuangsart 1973, Polunin 1975, IUCN Red Data Book 1975). See the Introductory Comments.

Conservation Measures Proposed: Although the Fisheries Act protects adults from capture, Thailand is among the world's leading exporters of tortoise-shell. Immediate action is needed to discourage this trade and to curtail hunting pressures on the already depopulated turtles. Hatchery programs raising young to supplement natural hatches should actively seek out hawksbill eggs and transport them to secure beaches for hatching. See the Introductory Comments.

Tao tu nu, tao saeng-atit, green turtle

Chelonia mydas (Linnaeus 1758)

Reptilia, Testudines, Cheloniidae

Status: Endangered.
USFWS (1980a): Threatened.
IUCN (1979) : Threatened.
CITES (1979) : Appendix I.
IUCN Red Data Book (1975): Endangered.
Thai Fisheries Act of B.E. 2490 (1947): Capture forbidden.

Population Size and Trend: Although it has recently declined in Thai waters it remains the most common sea turtle in the Gulf of Thailand and one of the most common on all Thai coasts. Before the recent decline at Tarutao Marine National Park it was an abundant turtle there. Within recorded history Chelonia numbered in the tens of millions in the world's warmer oceans. Overexploited for its flesh, eggs, and other products, it is drastically reduced throughout its range and is missing altogether from areas where it was once abundant. It is unlikely that more than 500,000 survive worldwide (IUCN Red Data Book 1975, Polunin 1975, Ehrenfeld 1979, A.H.V. Sharma personal communication).

Distribution and History of Distribution: The major nesting site of Thai Chelonia is Ko Kram in the Gulf of Thailand. Tiny Ko Kra off Nakhon Si Thammarat and other beaches in the Gulf are still used by this species. It is known to breed at Tarutao Marine National Park in Changwat Satun, at the Laem Phan Wa marine reserve (Phuket Marine Biological Center) and elsewhere in Changwat Phuket, along the beaches of Changwat Phangnga, and at other suitable sites on the west coast. Green turtles feed and breed in tropical and subtropical oceans around the world (Penyapol 1957, Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Polunin 1975, Ehrenfeld 1979, Polunin and Sumertha Nuitja 1979).

Geographical Status: C. mydas is widely distributed in both oceans that touch Thailand.

Habitat Requirements and Habitat Trend: Green turtles are found in oceans where the water temperature does not fall below 20° C in the coldest month. They do wander into colder seas at times, but breeding and feeding are restricted to the lower latitudes. Hatchlings and juveniles are carnivorous until about age 6 months, preferring to dine on shrimp. Adults are primarily herbivorous, specializing on sea grass (marine angiosperm beds), but sea weeds (algae), crustaceans, molluscs, and fish are also taken. These turtles have recently been shown to have gut bacteria that aid them in digesting cellulose, an unusual adaptation for a poikilotherm ("cold blooded" animal). No extensive beds of marine angiosperms are known to exist in Thai waters, but Polunin (1975) reported some at Makam Bay and Chalong Bay in Changwat Phuket and possibly along the west coast of Ko Samui in the Gulf of Thailand. Greens are famous for their long distance migrations between sea grass beds and nesting beaches. The grass beds occur in shallows, often on continental shelves, and are thus sensitive to trawling, siltation, and

other disruptive forces (Smith 1931, Penyapol 1957, IUCN Red Data Book 1975, Polunin 1975, Ehrenfeld 1979, Polunin and Sumertha Nuitja 1979).

Vulnerability of Species and Habitat: This species has often been called the most valuable (economically) reptile in the world. The key factor in its decline has been the delectable flavor of its flesh. In Thailand and around the world it is the preferred turtle for soup. Today adults range from 90 to 225 kg, and before the relentless overexploitation of recent times specimens over 360 kg were taken. The eggs are widely available in Thai markets and sell for US $.01-.015. Shells, dried curios, and other products are also to be had (Fisher et al. 1969, IUCN Red Data Book 1975, Polunin 1975, Lekagul and Damman 1977, Ehrenfeld 1979).

Causes of Threat: See the Introductory Comments.

Responses to Habitat Modification: Unknown.

Demographic Parameters: In the wild, green turtles may take 8-15 years or longer to reach sexual maturity. In the Gulf of Thailand nesting has been reported throughout the year, being concentrated in March-September (peak in June) at Ko Kram and December-February at Ko Kra. At Phuket on the west coast *Chelonia* nests from October to April, with a peak in December and January. The timing and location of sea turtle nesting in Thai waters may be affected by vagaries in the monsoons. A female might not nest every year (2-year, 3-year, and longer cycles are suspected), but will often return time and again to the same beach. Clutches range from 3 to 180 eggs. The mean of over 8,000 clutches studied by Hendrickson (1958) in Malaya and Sarawak was 105 eggs. Females often lay several clutches per season, with extremes of 7-8 clutches on record. At Ko Kra in the Gulf incubation lasts 45-50 days. At Phuket on the west coast it lasts 50-60 days. Hatching success at Ko Kram is high; about 90 percent of the eggs yield hatchlings (Penyapol 1957, Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Ehrenfeld 1979, Wirot 1979). For detailed accounts of the biology of this turtle in Sri Lanka and peninsular Malaysia and Sarawak see Deraniyagala (1939) and Hendrickson (1958). See the Introductory Comments, also.

Key Behaviors: Greens are better known than most sea turtles. Mating generally takes place in the shallow waters near nesting beaches. Hendrickson (1958) reported numerous observations of this behavior in the region. Copulation occurs both at night and during the daytime near the surface. When in coition the male is often exposed above the surface and the two are quite vulnerable to hunters at this time. Many nesting sea turtles excavate only a pit for the eggs, but *Chelonia* digs a large body pit (as large as 2 m long and 1 m deep) and a second, smaller hole under the cloaca for the eggs. The impressive strength of the female is seen at this time -- sometimes trees are uprooted by her excavations. These turtles are gentle and will only rarely bite when provoked. In Thailand these are the turtles most frequently killed by trawlers. This may not be due merely to their abundance. Their habit of resting near the surface may make them especially vulnerable to this mortality (Polunin 1975, Ehrenfeld 1979).

Conservation Measures Taken: *Chelonia* is legally protected by the Thai Fisheries Act of B.E. 2490 (1947). The beach concession system has released many hatchlings in previous years (21,350 in 1965, for example). In Thailand small scale captive rearing has been conducted at Phuket and the naval station at Sattahip. The species can and is propagated in captivity. Archie

Carr of the Caribbean Conservation Corporation hatched and flew greens from the protected beach at Tortugero in Costa Rica to various places in the Caribbean for release to supplement natural populations (Fisher et al. 1969, Phasuk and Rongmuangsart 1973, Polunin 1975).

Conservation Measures Proposed: Turtles nesting at Ko Kra and Ko Kram should be protected from capture, disturbance, and habitat alteration. It is hoped that the Royal Thai Navy will continue their worthy efforts to conserve the turtles at Ko Kram. A 6-10 year ban on all green turtle harvest should be considered. Efforts to acquire viable eggs for hatching at protected beaches should be pursued vigorously. The seasonal movements and foraging grounds of the Thai green turtles need to be identified and studied. The extent of marine angiosperm beds in Thailand's coastal waters should be determined. Green turtles are the only edible creature capable of turning the world's sea grass beds into human food on a large scale. Management of this turtle on a sustained yield basis would have to include protection of the nesting beaches and foraging grounds. These animals help maintain the sea grass ecosystem by cropping it back and thus providing a continuous supply of young, relatively nutritious growth. The effects of trawling, increased siltation in coastal waters, and water pollution in general on the sea grass habitat need to be investigated, as do the basic life history attributes of the green turtle in Thai waters.

Tao ta le, tao ya, tao charamed, loggerhead turtle

Caretta caretta (Linnaeus 1758)

Reptilia, Testudines, Cheloniidae

Status: Endangered.
USFWS (1980a): Threatened.
IUCN (1979) : Threatened.
CITES (1979) : Appendix I.
IUCN Red Data Book (1975): Vulnerable.
IUCN (1968): Threatened.
Thai Fisheries Act of B.E.2490 (1947): Capture forbidden.

Population Size and Trend: There are very few reliable data on the status of this turtle in Southeast Asia. It has become the rarest of the five Thai sea turtles. It is known to have declined in many parts of its wide range. There are probably no more than 100,000 adult females remaining in the whole world (Ehrenfeld 1979, IUCN 1979, Polunin and Sumertha Nuitja 1979, Wirot 1979, A.H.V. Sharma personal communication).

Distribution and History of Distribution: The temperate and tropical oceans of the world. This is the only sea turtle that breeds outside the tropics to a significant degree. There are records of this animal from the Gulf of Thailand and the west coast (Deraniyagala 1939, Penyapol 1957, Phasuk and Rongmuangsart 1973, Polunin 1977, Ehrenfeld 1979).

Geographical Status: Thailand's tropical seacoasts are lower in latitude than the beaches this reptile normally prefers for nesting.

Habitat Requirements and Habitat Trend: Caretta is said to prefer the marine littoral zone, especially rocky shallows and reefs. It breeds on surf-swept sandy beaches and feeds on molluscs, crustaceans, and other animals (Smith 1931, Deraniyagala 1939, IUCN Red Data Book 1975, Ehrenfeld 1979). See the Introductory Comments.

Vulnerability of Species and Habitat: The flesh of the loggerhead is said to be inferior in quality. See the Introductory Comments.

Causes of Threat: See the Introductory Comments.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: Loggerheads are thought to usually breed in alternate years. Most breeding at Phuket occurs from October to February. The clutch size ranges from 60-200 eggs with an average of about 126. A higher incubation temperature will produce a higher fraction of females in the hatchlings. Incubation lasts about 55 days. The loggerhead may breed three times in one season. Adults weigh 140-180 kg and have reached 230 kg on occasion (Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Ehrenfeld 1979).

Key Behaviors: These turtles are aggressive and will bite savagely, even when pulled into boats (Deraniyagala 1939).

Conservation Measures Taken: See the Introductory Comments.

Conservation Measures Proposed: The current status of the loggerhead in Southeast Asia needs to be ascertained. The IUCN Red Data Book (1975) considers the potential for captive breeding to be "virtually nil". See the Introductory Comments.

Tao-ma-fuang, leatherback or leathery turtle

Dermochelys coriacea (Linnaeus 1766)

Reptilia, Testudines, Dermochelyidae

Status: Endangered.
USFWS (1980a): Endangered.
IUCN (1979) : Threatened.
CITES (1979) : Appendix I.
IUCN Red Data Book (1975): Endangered.
IUCN (1968): Threatened.

Population Size and Trend: In the last century and the early part of the present one this turtle was quite abundant in some areas. The world's population of leatherbacks is now small, vulnerable, and declining. There are probably less than 50,000 adult females surviving. In Thailand this form has become rare (Deraniyagala 1939, Fisher et al. 1969, IUCN Red Data Book 1975, Polunin and Sumertha Nuitja 1979, A.H.V. Sharma personal communication).

Distribution and History of Distribution: The leatherback nests in the tropics but regularly feeds in colder waters when not breeding. It inhabits the Atlantic, the Pacific, and the Indian Oceans and the Mediterranean Sea. The two major nesting areas that remain are at French Guiana in the New World and at Trengganu Beach in Malaysia in the Old World. It is found all along Thailand's west coast. The airport beach in Changwat Phuket is the most important Thai beach for this species. It also breeds regularly at the Laem Phan Wa marine reserve at Phuket Marine Biological Center. The coasts of Changwat Phangnga also are used by this species (Penyapol 1957, Bustard 1972, Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Polunin 1975, Lekagul and Damman 1977, Bhaskar 1979, Polunin and Sumertha Nuitja 1979, Wirot 1979).

Geographical Status: This turtle occurs widely in both oceans touching Thailand, but it is rare or absent over much of its former range.

Habitat Requirements and Habitat Trend: The airport beach in Phuket, like other beaches Dermochelys uses in Thailand, has a steep profile and coarse grained sand seasonally exposed to rough seas. This turtle is thought to subsist almost entirely on jellyfish. This makes it very difficult to keep in captivity (IUCN Red Data Book 1975, Polunin 1975, Polunin and Sumertha Nuitja 1979).

Vulnerability of Species and Habitat: This is by far the world's largest living turtle. The flesh is rarely eaten but is sometimes used as bait. The shell has little or no commercial value. The primary exploitation of this species by man is for its eggs. They are the largest of sea turtle eggs, measuring 5-5.5 cm in diameter, about the size of a billiard ball. Although most sea turtle eggs collected in Thailand are sold and consumed near the place they were collected, these are considered a specialty item and are shipped to distant markets, where they command premium prices. Polunin (1975) counted 500 D. coriacea eggs for sale at Bangkok's Sunday Market on 13 July

and 800 on 27 July, 1974. The going price at that time was US $.25. Because of their great value leatherback eggs are not usually handed over to fisheries stations (Bustard 1972, Phasuk and Rongmuangsart 1973, Polunin 1975, Lekagul 1977, Polunin and Sumertha Nuitja 1979).

Causes of Threat: The thorough removal of the eggs of this species from Thailand's beaches threatens to extirpate the species. See the Introductory Comments.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The main breeding season at Phuket is October-April. An adult female may nest 4-10 times a season at about 10 day intervals. The usual clutch is 80-110 eggs or more. The incubation at Phuket takes 65-70 days or longer, longer than for most sea turtles. From hatchlings 1-2 cm in length, leatherbacks grow to typical adult sizes of 300-360 kg. If left unmolested some grow to truly giant size: greater than 2 m in length and weights of over 680 kg (Smith 1931, Bustard 1972, Phasuk and Rongmuangsart 1973, IUCN Red Data Book 1975, Lekagul and Damman 1977, Ehrenfeld 1979, Wirot 1979).

Key Behaviors: The nesting behavior was described in detail in Deraniyagala's (1939) classic account. Leathery turtles are rapid swimmers and apparently make long, poorly understood migrations (Smith 1931, IUCN Red Data Book 1975). See the Introductory Comments.

Conservation Measures Taken: Because of the poor success attained in captive rearing efforts (largely due to the animal's specialized diet), conservation of wild populations must be a major concern of all managing agencies. Although some leatherbacks have been hatched under Thailand's beach concessions program, the number is far outstripped by the eggs sent to market. No Thai law specifically protects this species.

Conservation Measures Proposed: Thailand is fortunate to have a viable breeding population of Dermochelys in this decade. Hatching and release of young on rental beaches should be carefully monitored. The Thai government should consider giving this animal (eggs and adults) complete legal protection for the time being. The Malayan Nature Society has had good success with transporting eggs to special protected enclosures for hatching. The Malaysian Fisheries Department has assumed operation of the hatcheries (IUCN Red Data Book 1975). Thai Marine Fisheries Division officials should study the methods used in Malaysia and consider adopting them. Cooperative tagging studies with other nations in the region would be an important first step in attempting to learn more about the habits of Thailand's Dermochelys. See the Introductory Comments.

Man lai, ta pab hua gob, griu dao, grau kaew, giant soft-shelled turtle

Pelochelys bibroni (Owen 1853)

Reptilia, Testudines, Trionychidae

Status: Threatened.
IUCN (1968): Threatened.

Population Size and Trend: Unknown. Although this species is widely distributed, it is nowhere abundant. It is currently threatened with extinction in Thailand (IUCN 1968).

Distribution and History of Distribution: P. bibroni is one of the most widely distributed of the freshwater turtles. In Thailand it is known definitely from the Chao Phraya in Bangkok, from Changwat Tak, Changwat Phra Nakhon Si Ayutthaya, Changwat Nakhon Si Thammarat, and Changwat Kanchanaburi. It probably ranges over much of western and all of peninsular Thailand. It has also been recorded from "Indochina", Hainan, southern mainland China, Burma, India, Sumatra, Java, Borneo, the Philippines, and New Guinea. Taylor (1970) wrote that its wide distribution may be due in part to people carrying them from place to place as food items (Smith 1931, Taylor 1970, Radhakrishnan-Nair and Badrudeen 1975, Wirot 1979).

Geographical Status: This aquatic species is widespread and occurs in a broad diversity of habitats. The Thai population is central to the species' overall range.

Habitat Requirements and Habitat Trend: In Thailand it is primarily an inhabitant of deep and slow-moving rivers upstream of salt intrusion (Smith 1931). A specimen was recently taken at sea off Mandapam in southern India (Radhakrishnan-Nair and Badrudeen 1975), proving Boulenger's (1912) early contention that P. bibroni is salt-tolerant and occasionally enters the sea. A captive in a Manila aquarium ignored the fishes Cyprinus carpio and Megalops cyprinoides but readily fed on the mud fish, Ophiocephalus striatus (Taylor 1970).

Vulnerability of Species and Habitat: This species is the second largest of the world's living soft-shelled turtles. Its large size makes it quite conspicuous to human hunters.

Causes of Threat: Throughout its range P. bibroni is extensively harvested as human food.

Responses to Habitat Modification: Unknown.

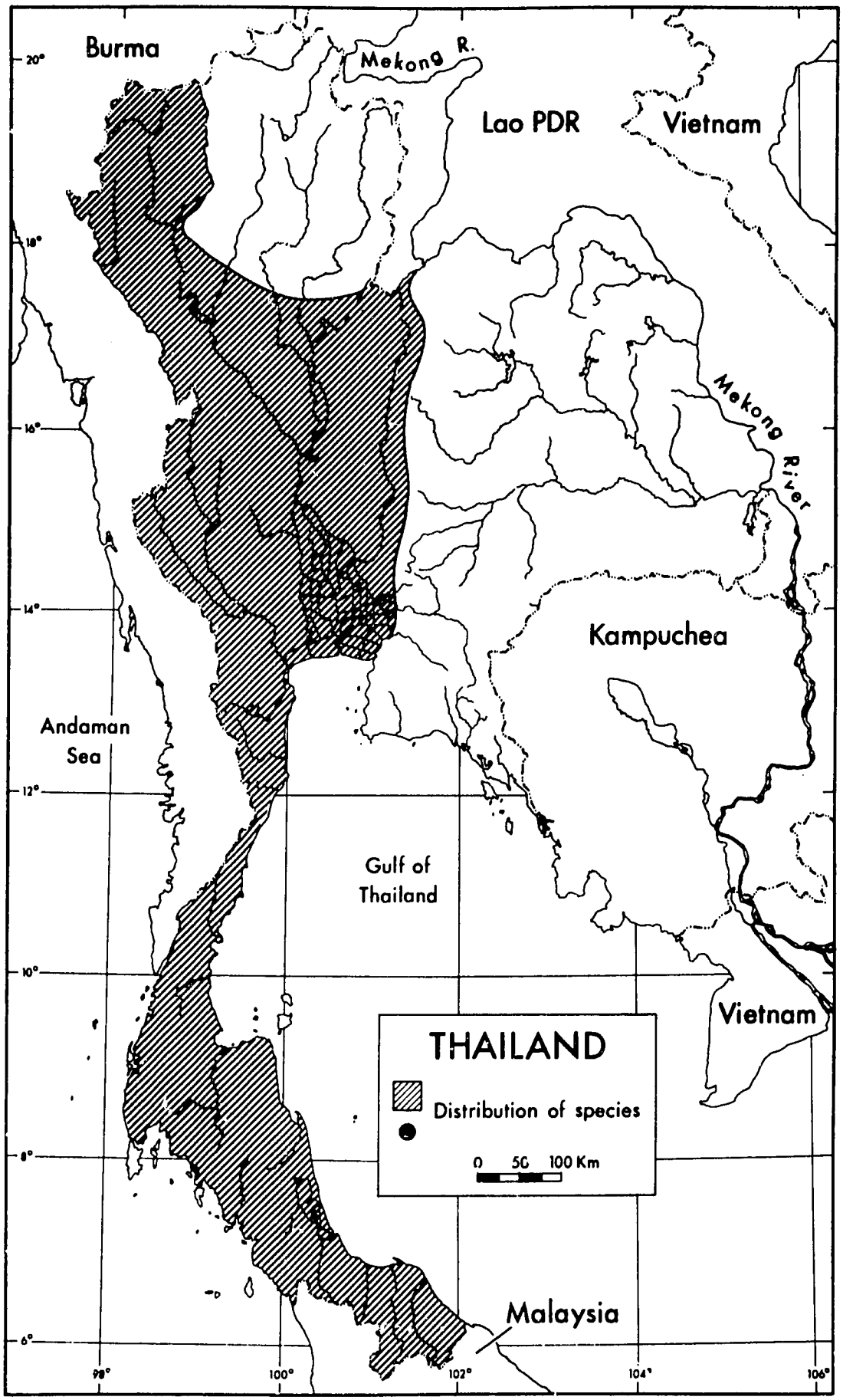
Demographic Characteristics: The female lays "a large number of eggs" (Wirot 1979). Adults reach a carapace length of almost 1 m and weigh as much as 85 kg (Wirot 1979).

Key Behaviors: This animal will bite when provoked. It often remains underwater for prolonged periods, apparently by absorbing oxygen from the water through its pharynx. The captive of Radhakrishnan-Nair and Badrudeen

(1975) was observed to bury all but its head in the sand substrate. In areas where P. bibroni routinely enters the sea its populations would tend to be spread over a much wider area than in areas where it sticks to freshwater.

Conservation Measures Taken: None.

Conservation Measures Proposed: IUCN (1979) recommended that habitat for P. bibroni in Thailand should be identified and brought under protection. Research is needed to determine its role in fisheries and in the freshwater community in general. Basic research on its life history and ecology in Thailand is needed to help formulate management programs that would allow harvest on a sustained yield basis. Laws should be considered to protect the species and its habitat and to regulate trade. Because it sometimes enters the sea, conservation measures need to be international in scope.



Pelochelys bibroni

Family Crocodylidae - The Crocodiles

Introductory Comments

Thailand historically had three wild crocodilians, the saltwater crocodile, Crocodylus porosus, the Siamese freshwater crocodile, C. siamensis, and the false gavial, Tomistoma schlegelii. All are approaching extinction in the wild in Thai waters. A fourth species, the mugger crocodile, C. palustris, is known from Burma and the Malay peninsula and has long been expected to occur in Thailand, although its presence there has never been established (Taylor 1970).

The saltwater crocodile is one of the few animals alive today that regularly eats people. The Thais have long considered crocodiles to be malevolent pests. "Crocodiles are often mentioned in classic Thai folk tales, in which they usually play the part of the villain" (IUCN 1971). Their former numbers are hard to assess, but the steady and dramatic decline of the Malaysian crocodile skin trade since 1953 (IUCN 1979, Whitaker 1979) attests to a depletion of natural populations. The world's trade in crocodile skins used to peak at over two million skins per annum, but today most of the world's 22 species survive only in preserves and breeding stations. Most of this decline is directly attributable to hunting for skins, aggravated by habitat loss, trade in live specimens, and malicious killing (Whitaker and Daniel 1978).

Today the depletion of crocodilian stocks continues worldwide. A Sarawak National Parks and Wildlife Officer summarized the factors contributing to the crocodile decline in his area: the pressures of a burgeoning human population, the proliferation of power boats and modern firearms, and increased logging activities, with attendant erosion of river banks and log rafting in rivers (Whitaker 1979). Laws protecting crocodiles in Southeast Asia are generally inadequate and poorly enforced. In Thailand they are lacking altogether (IUCN 1971, Whitaker 1979).

International trade in these animals is especially difficult to monitor and control. Live and dead specimens are obtained by raiding nests in Malaysia and are shipped to Singapore for sale elsewhere (Whitaker 1979). Such transshipment is common in the trade. King (1974) cited a case of a T. schlegelii imported to the United States from Sri Lanka, even though it occurs naturally only in south Thailand, Indonesia, and Malaysia (Taylor 1970).

Crocodiles are a potentially renewable natural resource. Their role in controlling predatory fish, birds, and mammals is well established (Whitaker 1979). In Thailand today high-powered rifles are ubiquitous. A crocodile skin can earn one a half-year's wages. Persistent, unregulated hunting, coupled with habitat destruction, makes it doubtful whether crocodilians can coexist with man in Thailand under the present circumstances (IUCN 1971).

The future of two Thai crocodilians, C. siamensis and C. porosus, rests in the hands of Utai Yangprapakorn. The crocodile farm he founded at Samut Prakan in 1950 has grown to be one of the largest in the world. It currently houses over 16,000 individuals and includes an active breeding population of over 400 sexually mature adults. There are far more C. siamensis at Samut Prakan than all the ones surviving in the wild and in the world's zoos combined. Although the farm has been hailed as a breakthrough in

crocodile conservation and the Yangprapakorns have offered to donate stock for release in the wild when suitable preserves are developed, they allow the two species to hybridize (Whitaker 1979) because of the rapid growth of the hybrids. With the future of C. siamensis so much under their control it is regrettable that they do not take measures to protect its genetic integrity. Hence, it would probably be preferable to base reintroductions on zoo populations whose genetic purity has been preserved.

We know of no current research being carried on in Thailand on the few remaining wild crocodilians or on potential sites for reintroducing them. The Tomistoma remains a mystery to modern science. Basic studies on the biology of wild populations are urgently needed to provide a basis for sound management plans.

For the forseeable future we concur with IUCN (1971) that, as members of the wild Thai herpetofauna, crocodilians "seem to be doomed".

Saltwater crocodile, buaya muara, charakee nam-khen

Crocodylus porosus Schneider 1801

Reptilia, Crocodilia, Crocodylidae

Status: Probably extirpated.
USFWS (1980a): Endangered.
CITES (1979) : Appendix I.
IUCN (1979) : Threatened.
IUCN Red Data Book (1979): Vulnerable, greatly reduced in numbers throuthout its range.
IUCN (1971): Almost extinct in the wild in Thailand.

Population Size and Trend: "No more than ten adults are believed to remain in its range in southern Thailand" (King et al. 1979). There has been a dramatic decline in total world trade volume in C. porosus skins in the last decade, from 100,000 per year to 20,000 per year (King et al. 1979). Samut Prakan Crocodile Farm has extensive holdings of this species, but encourages them to hybridize with C. siamensis (Whitaker 1979). The last specimen from Thailand came from the area of Ko Tarutao in Changwat Satun in 1971, and no sightings or specimens have been confirmed since then (Boonruang Saisorn personal communication). Numbers are greatly reduced over the species entire range, except in Papua New Guinea (IUCN Red Data Book 1979): surviving populations are estimated at 300 on the mainland of India, 170-330 in the Andaman Islands, and 500-700 in Sri Lanka.

Distribution and History of Distribution: "Historically found from Cochin in southwest India, and Sri Lanka, east along the coast through Bangladesh, Burma, Thailand, Malaysia, Kampuchea, Vietnam extreme southeast China, Philippines, Caroline Islands, Indonesia, Moluccas, Timor, Aru and Kei Islands, New Guinea, Bismarck Archipelago, Solomon Islands, New Hebrides, northern Australia. Scattered records [occur] from Fiji and Cocos Keeling Islands" (Neill 1971 in King et al. 1979).

Geographical Status: Salt water crocodiles are widespread but restricted to isolated portions of their former range.

Habitat Requirements and Habitat Trend: These animals prefer salt water and are usually found in estuarine situations and coastal waters. Sometimes they are found in fresh water or at sea, far from the coasts (Schmidt 1928, Taylor 1970, IUCN Red Data Book 1979). Smith (1931) wrote that in Thailand they do not normally invade fresh water but are commonly found at the mouths of muddy rivers.

Vulnerability of Species and Habitat: Perhaps the most vulnerable attribute of porosus is its hide, which is considered to be the finest of crocodile leathers. In areas where more than one crocodile species occur C. porosus is actively sought (IUCN Red Data Book 1979). This species does not tolerate much human disturbance, especially when nesting. The loss of suitable basking and nesting sites and the heavy human utilization of coastal areas that this animal depends on are important factors in its demise (USFWS 1980b).

Causes of Threat: In addition to intense hunting for hides, live specimens, and food, its occasional habit of feeding on Homo sapiens has caused many C. porosus to be destroyed as "vermin." Prices of porosus hides continue to climb. In Thailand the animals and their eggs are eaten (King and Brazaitis 1971, IUCN 1971, Whitaker and Daniel 1978, Whitaker 1979, King et al. 1979, USFWS 1980b).

Responses to Habitat Modification: The effects of increased silt loads in estuaries, alteration of mangrove forests, and the destruction of coral reef habitats on C. porosus must be profound, but they are unknown.

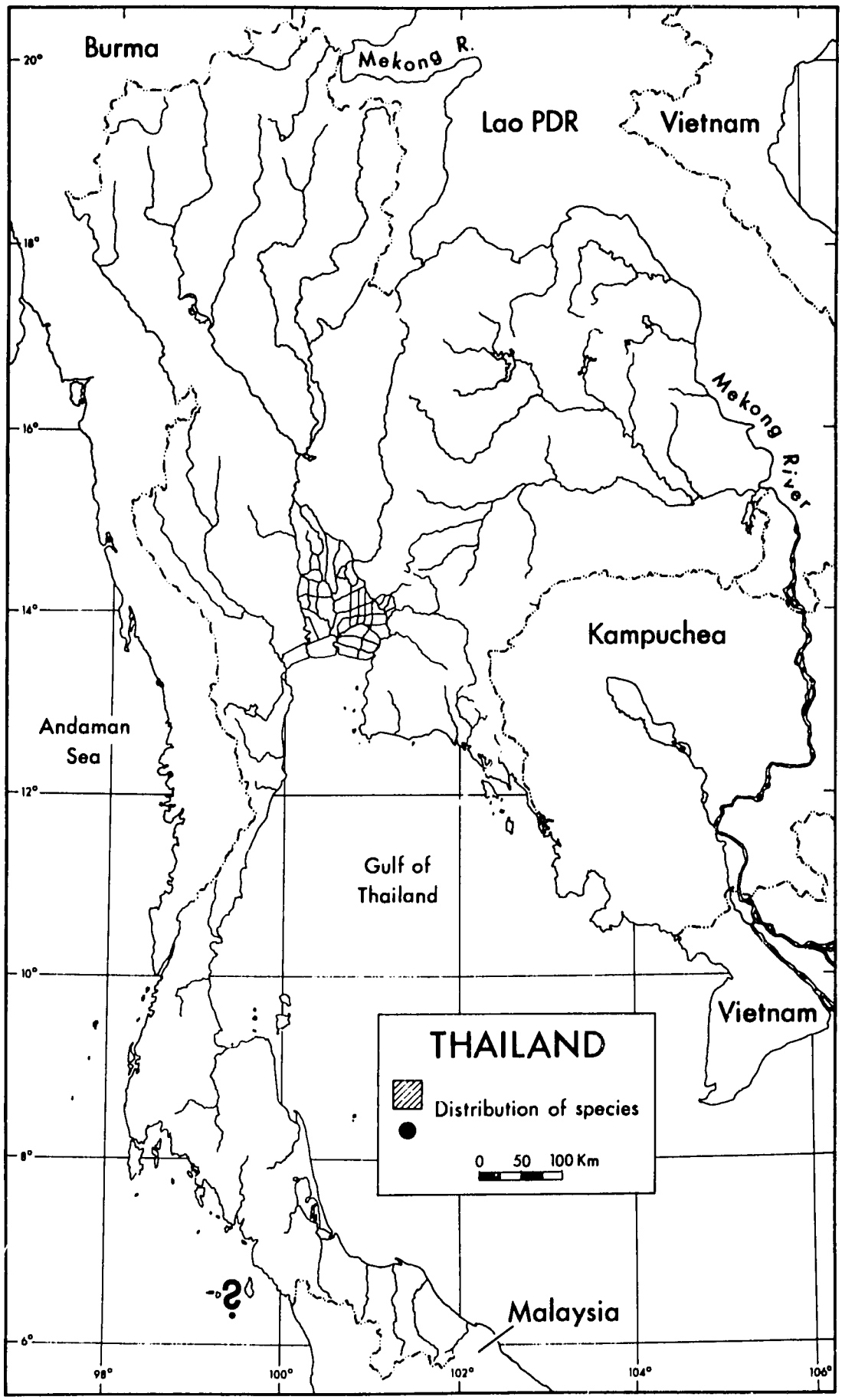
Demographic Characteristics: In the wild C. porosus does not breed until it reaches a relatively large size (approximately 2.2 m), so many animals reach a size attractive to hunters before reaching sexual maturity. 25-90 eggs are deposited in a nest mound of decomposing organic debris. The young hatch in about three months (IUCN Red Data Book 1979). At Samut Prakan Crocodile Farm demographic characteristics are similar to those for C. siamensis: Captive porosus are sexually mature at 12-15 years of age. Females lay 30-50 eggs, 40-50 percent of which hatch in 78-80 days. In the first year of life 20-30 percent die; thereafter annual mortality is less than 5 percent. Samut Prakan's breeding stock ranges from 12-35 years of age. One captive at the National Zoological Park (Smithsonian Institution) in Washington D.C. lived past 40 years of age (King and Dobbs 1975).

Key Behaviors: Female defense of the nest, as in other crocodilians, makes the species especially vulnerable to hunters. The infrequent but regular attacks on man result in much human persecution. The oceangoing habit of this species tends to spread individuals over a wide area, further complicating problems brought on by reduced densities and requiring that conservation measures be international in scope.

Conservation Measures Taken: Much habitat of the former population in the vicinity of Ko Tarutao is included in Tarutao Marine National Park. Hunting and export of skins are now prohibited in Sri Lanka, India, and Australia. India has established 2 sanctuaries for this species. In Papua New Guinea the species is carefully managed while the economic interest of subsistence hunters is protected, through a program of research, licensed harvesting, minimum size limits on marketed skins, and public education (IUCN Red Data Book 1979). Research also is under way in Australia.

Conservation Measures Proposed: Thailand should enact and enforce laws to protect the few remaining crocodiles and any that might be reintroduced. This form is perhaps the largest of living reptiles, rarely reaching lengths of 10 m (Taylor 1970) and should not be allowed to go extinct because of human exploitation. There are fewer than 50 in the zoos of the United States and Europe (King and Dobbs 1975, Honegger 1975) and most of them are not

reproductive. The conservation of wild populations, then, is of great importance to the continued existence of this species. The feasibility of restocking portions of Tarutao Marine National Park with salt water crocodiles should be studied. Reintroduction there would be fruitless without substantial support for personnel and equipment for enforced protection.



Crocodylus porosus

Siamese freshwater crocodile, buaya muara, charakee nam-chued

Crocodylus siamensis Schneider 1801

Reptilia, Crocodilia, Crocodylidae

Status: Probably extirpated.
USFWS (1980a): Endangered.
CITES (1979) : Appendix I.
IUCN (1979) : Threatened.
MAB (1979) : Endangered.
IUCN Red Data Book (1975): Endangered.
IUCN (1971): Quite rare, approaching extinction in the wild.

Population Size and Trend: The Siamese crocodile became scarce in Thailand in the early 1940's (King and Brazaitis 1971). The wild population at Bung Boraphet in Changwat Nakhon Sawan is small (certainly fewer than 200 individuals) and declining. There have been no recent sightings of C. siamensis there. The commercial population at Samut Prakan numbers some 20,000 individuals, including siamensis x porosus hybrids (King and Brazaitis 1971, IUCN 1971, IUCN Red Data Book 1975, Whitaker and Daniel 1978, Whitaker 1979).

Distribution and History of Distribution: The only known surviving wild population is at Bung Boraphet and the status of that population is uncertain. Jeffrey McNeely believes that a few may survive in north Thailand in Changwat Loei (IUCN 1979). The animal was formerly found in Java, Borneo, Kampuchea, Vietnam, and much of central and peninsular Thailand (King and Brazaitis 1971, IUCN 1971, IUCN Red Data Book 1975, Whitaker and Daniel 1978, IUCN 1979, Whitaker 1979). Distribution records in Thailand include the upper Mae Nam Yom north of Phrae, the Mae Nam Khwae Noi near Sai Yok, the lower Mekong near Khemmarat, swamps near Chumphon in the peninsula, the stream connecting Thale Sap Luang and Thale Sap Songkhla in Changwat Songkhla, and the upper Pattani River (Smith 1919).

Geographical Status: Extirpation over most of its former range has made this crocodile a confined Thai endemic.

Habitat Requirements and Habitat Trend: Siamese crocodiles prefer freshwater lakes, rivers, and swamps, where they subsist on a varied diet. They were once abundant in the Mae Nam Kwae Noi in western Thailand (Taylor 1970) and in the stream connecting Thale Sap Luang and Thale Sap Songkhla in Changwat Songkhla in south Thailand. The habitat of the relict wild population at Bung Boraphet is threatened by encroachment of rice cultivation, which has reduced the wetland to 5,000 ha from an original 25,000 ha (IUCN 1979).

Vulnerability of Species and Habitat: Maternal attachment to nesting sites and defense of the young make crocodiles especially vulnerable to hunters. The lowland freshwater habitat that this species requires is coveted by man for agriculture and other development activities.

Causes to Threat: Unrestricted hunting for hides and live specimens is the primary cause of the alarming decline of this species. This has been aggravated by habitat destruction and malicious killing. The eggs and meat are eaten in Thailand (King and Brazaitis 1971, Whitaker 1979).

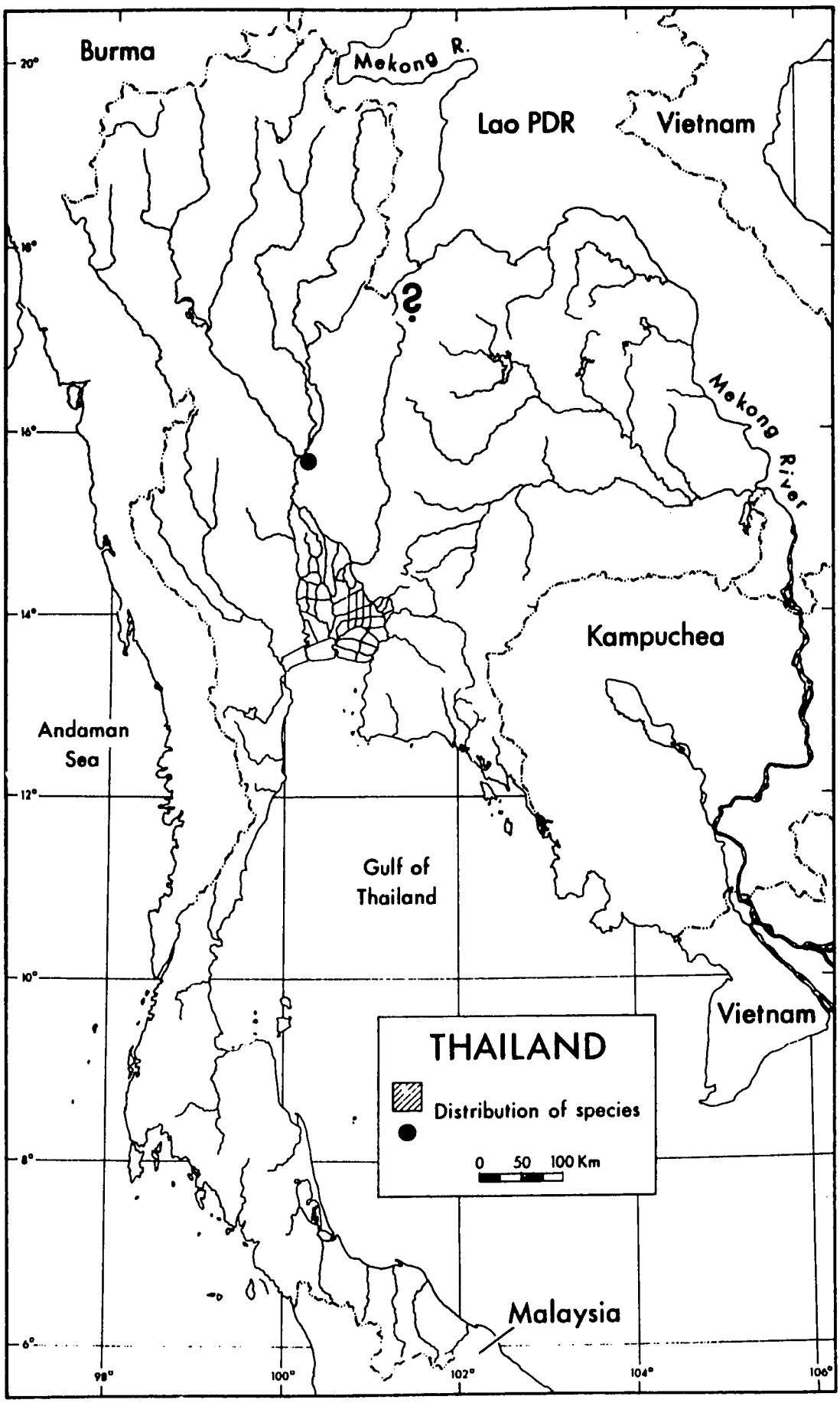
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The breeding rate in the wild is unknown (IUCN Red Data Book 1975). Wild adults average 3.15-3.8 m and may rarely reach 4 m (Taylor 1970, IUCN 1971). The following information (IUCN 1971) describes the captive stock at Samut Prakan: Siamese crocodiles reach sexual maturity at 10-12 years. During the breeding season one male forms a relationship with only two females. Mating takes place mostly at night from December to March. The female builds a nest from the vegetation provided and lays some 20-40 eggs in late April through July. She actively defends the nest against other females. Human intervention helps maintain the nest temperature between 95° and 98° F by adjusting the amount of rotting vegetation. In 67 or 68 days 50-60 percent of the eggs hatch. Hatchlings are raised apart from adults. In the first year 20-30 percent of the young die. Thereafter annual mortality is less than 5 percent. Utai's breeding stock ranges from 12 to 35 years of age.

Key Behaviors: Female defense of the nest, although it enhances survivorship of the young in natural situations, makes the crocodiles quite susceptible to hunters. The use of exposed basking sites also makes them more visible to humans.

Conservation Measures Taken: None.

Conservation Measures Proposed: Nocturnal surveys at Bung Boraphet, with boats and searchlights, should be conducted to determine if Siamese crocodiles survive there. Management plans for that wetland should include considerations of *C. siamensis*. Encroachment by rice cultivation should be halted. Upgrading its protection status from Non-hunting Area to Wildlife Sanctuary or a similar reserve should be considered and the feasibility of restocking it with *C. siamensis* should be studied. If reintroduction in Thailand is accomplished, the population should be given complete protection until it reaches the carrying capacity of its environment. Thereafter a research and management program should be instituted to allow harvest of *C. siamensis* on a long-term sustainable basis. The management of Samut Prakan Crocodile Farm should be encouraged to maintain pure parental stock of the two *Crocodylus* species. Zoos and aquaria in the United States hold approximately 24 Siamese crocodiles, all sexually immature (King and Dobbs 1975). European zoos house some 11 individuals (Honegger 1975). In light of the cross-breeding allowed at Samut Prakan, these institutions should recognize their opportunity to help conserve the species by avoiding hybridization with other species and by pursuing cooperative breeding efforts.



Crocodylus siamensis

Tomistoma, false gavial, false gharial, buaya sinyulong, ta-khong

Tomistoma schlegelii (S. Müller 1838)

Reptilia, Crocodilia, Crocodylidae

Status: Probably extirpated.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN (1979): Threatened.
MAB (1979): Threatened.
IUCN Red Data Book (1979): Endangered.
IUCN (1971): Almost extinct in the wild in Thailand.
IUCN (1968): Threatened.

Population Size and Trend: Tomistoma may have recently become extinct in the wild in Thailand. If it exists, probably fewer than 20 individuals remain. Throughout its range there has been a rapid decline in recent years. It is clearly one of the most endangered of the world's crocodilians (IUCN 1971, Whitaker and Daniel 1978, Whitaker 1979).

Distribution and History of Distribution: T. schlegelii formerly occurred in southern Thailand, Malaysia, Sumatra, Borneo, and probably in other islands of the Indo-Australian Archipelago (Taylor 1970, King 1974). IUCN (1979) stated that a few individuals may still exist in Changwat Surat Thani. Fossil species of Tomistoma are known worldwide.

Geographical Status: The Thai population, if it exists, is peripheral, lying at the northern limits of the species' distribution.

Habitat Requirements and Habitat Trend: Tomistoma presumably prefers the freshwater lakes, rivers, canals, and swamps. Its diet is thought to be restricted to fish (Whitaker 1979).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Hunting for hides has decimated this species. Although it is close to extinction, batches of young still appear on the Thai and Singapore markets from time to time. Depletion of freshwater fish stocks may have indirectly contributed to the decline (Taylor 1970, King and Brazaitis 1971, Whitaker 1979).

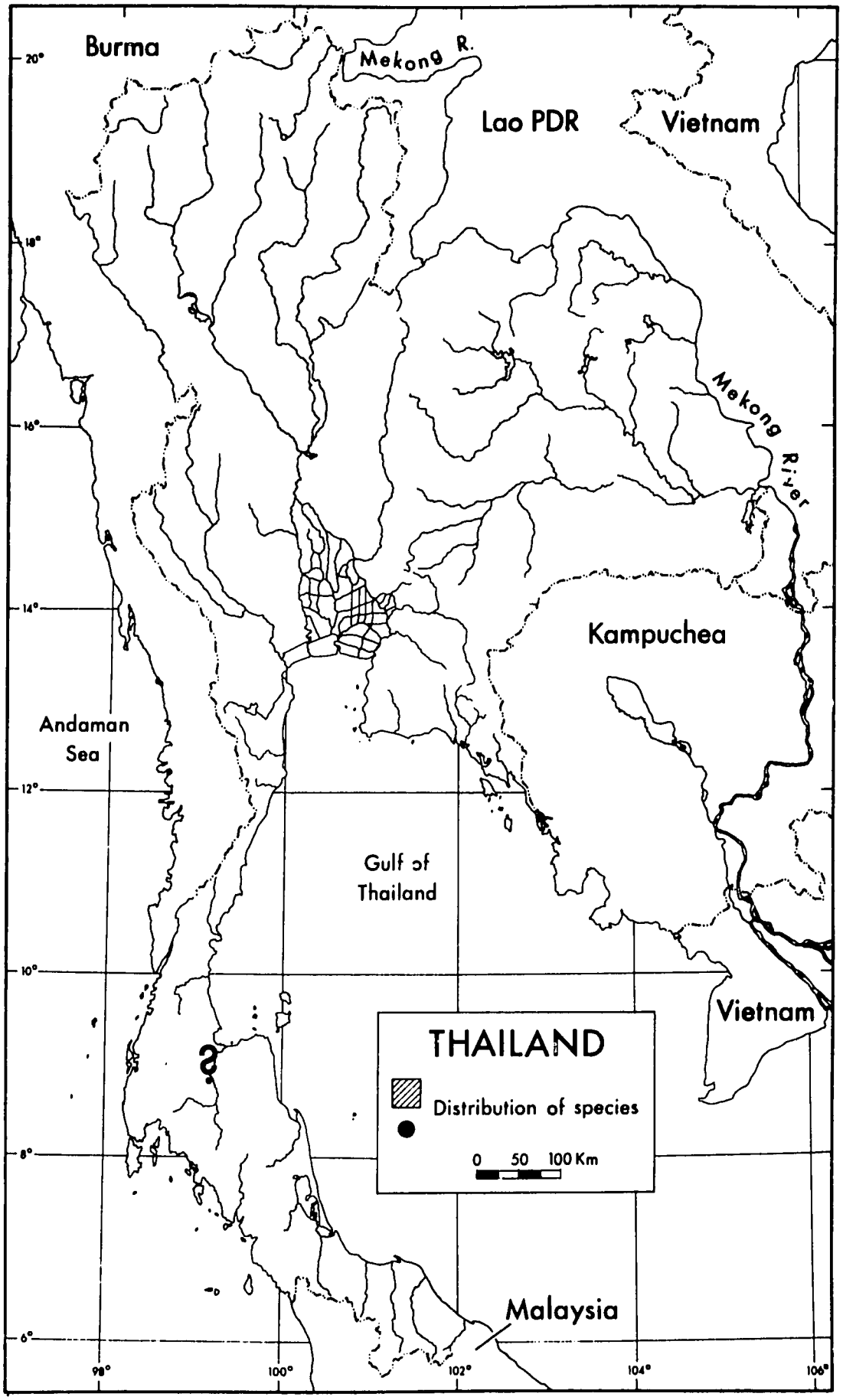
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown. Adults reach a maximum of some 5.2 m (Taylor 1970). Captive specimens are known to have lived at least 11 years (King and Dobbs 1975).

Key Behaviors: Whitaker (1979) calls this animal one of the last mysterious crocodiles. Its habits in the wild are almost entirely unknown. Recently it was discovered to burrow and spend much of its time in its hole. It is reputed to subsist on fish. Whitaker (1979) believes that "it is likely to play a positive role in the fisheries of the waterways" as a top carnivore. It has never been known to attack man.

Conservation Measures Taken: None.

Conservation Measures Proposed: Surveys to determine the locations of existing populations are needed. Laws should be enacted and enforced to regulate hunting and trade. American and European zoos hold about 50 individuals (King and Dobbs 1975, Honegger 1975). A few exist in the world's commercial crocodile farms, including about 170 at Samut Prakan Crocodile Farm south of Bangkok (IUCN Red Data Book 1979, our observation). Cooperative breeding efforts should be pursued, as most zoos that hold *Tomistoma* have only a single specimen. Romulus Whitaker (personal communication) is planning a study of *Tomistoma* in Malaysia and Indonesia. A wildlife reserve has been proposed in the upper Lalan River drainage, where the species survives in the river and at least 4 tributaries (Sudharma 1976).



Tomistoma schlegelii

Bengal monitor

Varanus bengalensis (Daudin 1802)

Reptilia, Squamata, Varanidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979) : Appendix I.
MAB (1979) : Endangered.

Population Size and Trend: Unknown at present. The Bengal monitor has been found to be common in Thailand in the past (Smith 1916, 1932) and more recently where good habitat remains (Seidensticker and McNeely 1974).

Distribution and History of Distribution: The Bengal monitor occurs in Nepal, India, Sri Lanka, Bangladesh, Burma, Thailand, Lao PDR, Kampuchea, Vietnam, and peninsular Malaysia (Boulenger 1885, Smith 1935, Taylor 1963).

Geographical Status: Thailand is central in the species' range.

Habitat Requirements and Habitat Trend: This terrestrial species lives in many types of forest, but especially dry dipterocarp forest, from lowlands to at least 1000 m elevation (M.A. Smith 1916, 1935, H.C. Smith 1931, Taylor 1963), but few details are known. If like most other monitors, this species is carnivorous and eats a wide variety of animals. From an original 80 percent, forest cover of Thailand has declined to 53 percent in 1961, 39 percent in 1973, and 25 percent in 1978 (Myers 1980).

Vulnerability of Species and Habitat: This species is threatened by deforestation and by harvesting, both for food (H.C. Smith 1931, M.A. Smith 1932) and export. From 1967 to 1971 the number of individuals exported from Thailand each year was 123, 96, 609, 1049, and 1664 (Royal Forestry Department 1972). The United States imported the following Bengal monitors from Thailand: from all sources, 380 and 682 live animals in 1970 and 1971, and 6 and 4207 pieces of skin products in 1970 and 1971; from Thailand, none in 1977, and 45 live animals in 1978 (USFWS 1974, CITES 1977, 1978). The United Kingdom reported importing a total of 52 Bengal monitors, all from Thailand, in 1977, but for the same year reported re-exporting 6338 skins to 7 countries, under the antiquated name *V. nebulosus*, giving a CITES Appendix II listing (TRAFFIC 1978). In 1978, the United Kingdom reported no imports of Bengal monitors but reported re-exporting 6362 "*V. nebulosus*" skins to 5 countries (TRAFFIC 1979).

Responses to Habitat Modification: Unknown.

Demographic Characteristics: Clutches include up to 25-30 eggs, which are laid early in the hot season (March and April) in Burma. Sexual maturity is attained at an age of 2-3 years or when total length is about 0.8 m (H.C. Smith 1931).

Key Behaviors: Individuals engage in pushing matches that may be territorial (R. Deraniyagala 1957). Females bury their eggs in the soil and then dig several false nests nearby (P. Deraniyagala 1957). Males feed more than females, grow faster, and use the best basking sites, displacing other individuals from them if necessary (Auffenberg 1979).

Conservation Measures Taken: Bengal monitors occur in Huai Kha Khaeng Wildlife Sanctuary (Seidensticker and McNeely 1974).

Conservation Measures Proposed: The first step in planning for the management of this species is to conduct a detailed survey of its distribution and abundance. Trade should be regulated on a quota system, with the quota adjusted according to population trends determined by monitoring population size. If monitoring is not feasible, quotas should be set and maintained well below recent export levels. If export levels then were to fall below that quota figure, the cause probably would be a drastic population decline. In response, trade should be banned for perhaps 6 years, after which even lower quotas could be re-established.

Red-headed monitor

Varanus rudicollis (Gray 1845)

Reptilia, Squamata, Varanidae

Status: Threatened.
CITES (1979): Appendix II.

Population Size and Trend: Unknown.

Distribution and History of Distribution: The red-headed monitor occurs in southern Burma and Thailand, peninsular Malaysia, Sumatra, Borneo, Banka, and the Philippines. In Thailand the species has been recorded in Changwats Ranong and Trang (Boulenger 1885, Taylor 1963, 1966).

Geographical Status: Thailand is the northern limit of this species' range.

Habitat Requirements and Habitat Trend: The red-headed monitor lives in primary forest and has been recorded up to 610 m in elevation (De Rooij 1915), but no other details are known. Habitat loss has been extensive.

Vulnerability of Species and Habitat: This species is vulnerable to hunting and its habitat to deforestation.

Causes of Threat: The red-headed monitor is threatened by deforestation and by harvesting for food and export. The United States imported 51 and 43 live V. rudicollis from all sources in 1970 and 1971 (USFWS 1974). In 1977 the United States imported none of this species from Thailand, but in 1978, 66 live animals were imported from Thailand (CITES 1977, 1978). The figure for 1980 was 37 animals (TRAFFIC 1981). The Federal Republic of Germany imported 5 V. rudicollis from Thailand in 1978 but none in 1979 (TRAFFIC 1980a). In 1978, 14 Thai V. rudicollis were imported into Switzerland, and 3 were imported into the United Kingdom (TRAFFIC 1978).

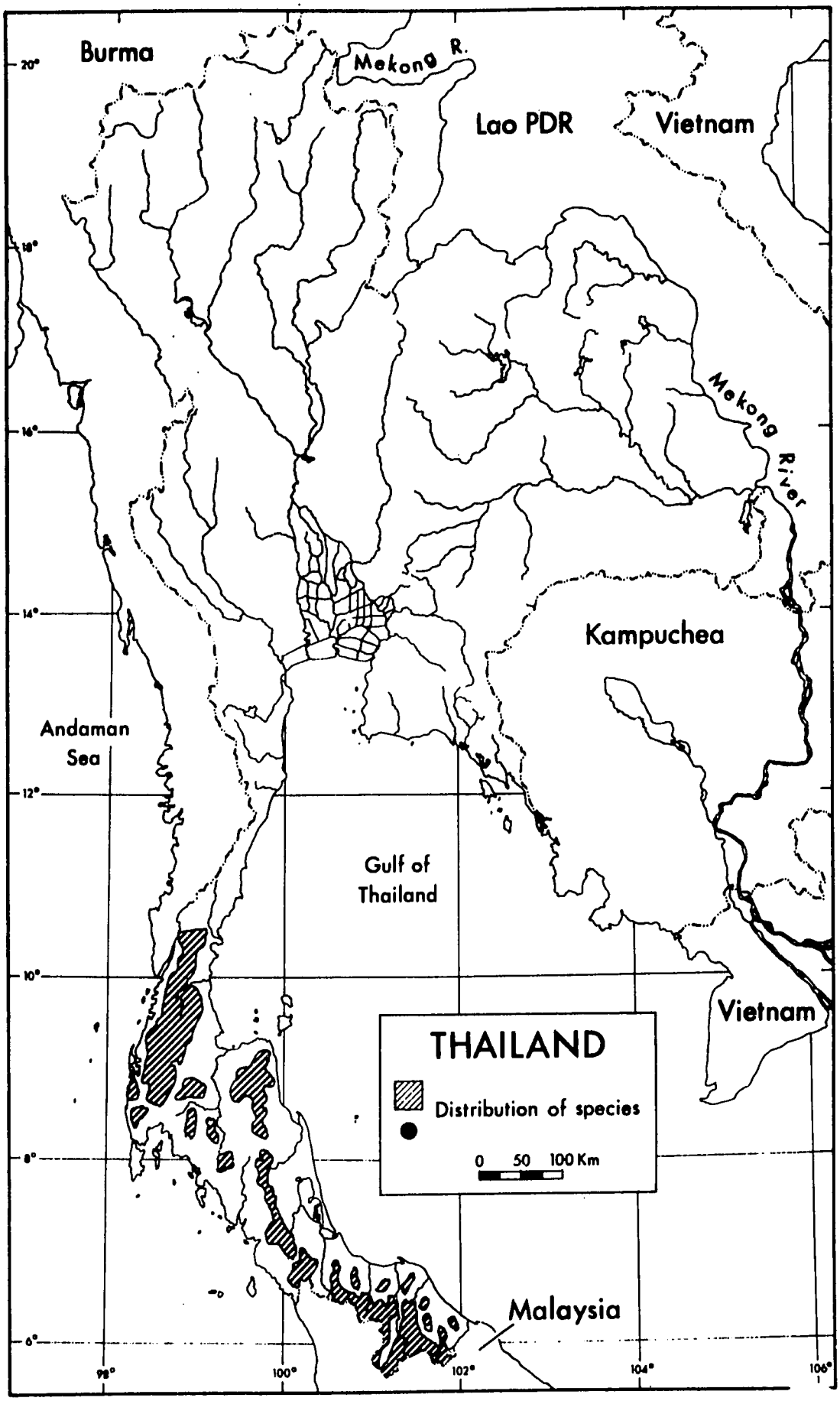
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: This species is arboreal.

Conservation Measures Taken: None.

Conservation Measures Proposed: The remaining forests in southern Thailand should be surveyed for this species.



Varanus rudicollis

Black jungle monitor

Varanus dumerilii (Schlegel 1844)

Reptilia, Squamata, Varanidae

Status: Threatened.
CITES (1979): Appendix II.

Population Size and Trend: Unknown. It was plentiful on Sir Charles Forbes Island, Burma (Smith 1931).

Distribution and History of Distribution: The black jungle monitor occurs in southern Burma and Thailand, peninsular Malaysia, Sumatra, Borneo, Batu Islands, Banka, Beliton, and Java. In Thailand the species is known from Changwat Trang (Boulenger 1885, de Rooij 1915, Taylor 1963).

Geographical Status: Thailand is the northern limit of the species' range.

Habitat Requirements and Habitat Trend: Unknown. Records exist from mangrove forest up to 1200 m elevation (de Rooij 1915, H.C. Smith 1931).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: In 1980, 64 black jungle monitors were exported from Thailand into the United States (TRAFFIC 198[illegible]).

Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: In captivity *V. dumerilii* swims and burrows well and is diurnal in its activity. Captive animals accepted raw meat, rodents, eggs, lizards, small fish, and crickets as food (Sprackland 1976).

Conservation Measures Taken: None.

Conservation Measures Proposed: The distribution and habitat of this poorly known species must be learned before anything more progressive can be done.

Burmese python

Python molurus bivittatus (Schlegel 1837)

Reptilia, Squamata, Boidae

Status: Threatened.
CITES (1979): Appendix II.
IUCN Red Data Book (1975): Vulnerable.

Population Size and Trend: The Burmese python is rare (Boulenger 1912, Smith 1943) and declining over most of its range (IUCN Red Data Book 1975).

Distribution and History of Distribution: This subspecies is found in southern China, Hong Kong, Hainan, Vietnam, Thailand, Burma, Java, Sumbawa, Borneo, and Celebes. Specific records from Thailand are published for Changwats Raheng, Lopburi, and Chon Buri (Schmidt 1927, Smith 1943, Taylor 1965). The other subspecies (*P. m. molurus*) occurs in India, Sri Lanka, Nepal, Bangladesh, and Pakistan.

Geographical Status: Thailand is central in the range of the Burmese python.

Habitat Requirements and Habitat Trend: Burmese pythons occur in a wide variety of habitats, from mangrove swamps to arid woodland to evergreen forest up to 2000 m elevation. Requirements include a large undisturbed area in which to hunt and hiding places near a permanent water source. The diet consists of small to medium-sized birds and mammals, particularly rodents. Vast areas of habitat have been lost (IUCN Red Data Book 1975, Whitaker 1978).

Vulnerability of Species and Habitat: The Burmese python is vulnerable to deforestation and harvest for food and export. The skin is highly prized for its beauty.

Causes of Threat: Much habitat has been deforested. The meat and fat have been consumed traditionally for food and supposed medicinal purposes (Schmidt 1927, Whitaker 1978). Burmese pythons exported from Thailand in 1967-71 numbered 47, 49, 119, 174, and 496 (Royal Forestry Department 1972). In 1977, 993 live individuals and 1000 skins were exported from Thailand to the United States (CITES 1977). In 1978, 6681 live individuals and 1000 m of skins were exported from Thailand to the United States (CITES 1977). In 1980, 5106 Burmese pythons were

exported from Thailand to the United States (TRAFFIC 1981). In 1979, 689 live Burmese pythons were exported from Thailand to the Federal Republic of Germany (TRAFFIC 1980b). In 1978, 298 Burmese pythons were exported from Thailand to the United Kingdom (TRAFFIC 1979).

Responses to Habitat Modification: Unknown.

Demographic Characteristics: This species is oviparous and reaches a length of up to 9 m. The clutch contains up to 107 eggs (Smith 1943), but the usual number is 30-50. The eggs are incubated by the mother, and they hatch after 2-3 months. Sexual maturity is reached at 3-5 years of age (IUCN Red Data Book 1975).

Key Behaviors: Mating occurs during hibernation in India, and eggs are laid in March-June (Whitaker 1978). The period from mating to egg-laying ranges from 60-120 days, varying with ambient temperature. Gravid females refuse to eat and begin to have elevated body temperature several weeks before the eggs are laid (Van Mierop and Barnard 1976). Spasmodic muscle contractions are used to generate heat, and the female coils around the eggs to incubate them for 55-66 days, losing 20 percent of her body weight in the process (Valenciennes 1841, Forbes 1881, Van Mierop and Barnard 1976, and many others). Males kept in captivity with a female established a stable, linear dominance hierarchy, and the subsequent frequency of matings was correlated with the hierarchical status of each male (Barker et al. 1979). Pythons sleep or bask in the day and travel about, hunting, at night. Large individuals have a regularly used home range (Whitaker 1978).

Conservation Measures Taken: None are known, but the species probably occurs in some of Thailand's national parks and wildlife sanctuaries.

Conservation Measures Proposed: This species difficult to study in the field except by radiotelemetry, so population monitoring is not feasible. The best that can be done is to maintain tracts of native forest and regulate trade on a quota basis. Quotas should be set substantially below recent export levels and will have to be maintained arbitrarily, without scientific justification, unless a method is discovered for monitoring population trends. If export levels fall below such a quota figure, a drastic population decline

probably would be the cause, and a complete ban on trade should be imposed for 7-10 years, after which lower quotas could be re-established. Burmese pythons breed well in captivity, so it has potential for captive breeding and rearing for market similar to Thailand's successful crocodile farming. Such endeavors should be stocked only from animals now in captivity, because supplementing them with wild-caught ones would aggravate the problem.

Blood or short python

Python curtus Schlegel 1872

Reptilia, Squamata, Boidae

Status: Threatened.
CITES (1979): Appendix II.

Population Size and Trend: Blood pythons are moderately common in good habitat (Ridley 1899). Populations probably are much reduced because of habitat loss.

Distribution and History of Distribution: This species occurs in southernmost Thailand, peninsular Malaysia, Singapore, Sumatra, and Borneo (Boulenger 1912, de Rooij 1917). In Thailand it is known only from Changwat Pattani (Taylor 1965).

Geographical Status: Thailand is on the extreme northern edge of the species' range.

Habitat Requirements and Habitat Trend: The few published remarks indicate that blood pythons inhabit swamp forest (Boulenger 1912, de Rooij 1917, Tweedie 1954). If so, most of their habitat has been lost to cutting, draining, and use of mangroves for charcoal. In captivity, rats are accepted as food.

Vulnerability of Species and Habitat: The blood python is vulnerable to habitat loss and harvest for food and export.

Causes of Threat: Very little of this species' habitat may remain in Thailand. The following figures indicate the extent of recent trade. In 1977, 1978, and 1980, 62, 568, and 147 live blood pythons were exported from Thailand to the United States (CITES 1977, 1978, TRAFFIC 1981). In 1978, 49 were exported from Thailand to the United Kingdom (TRAFFIC 1979). In 1979, 55 were exported from Thailand to the Federal Republic of Germany (TRAFFIC 1980).

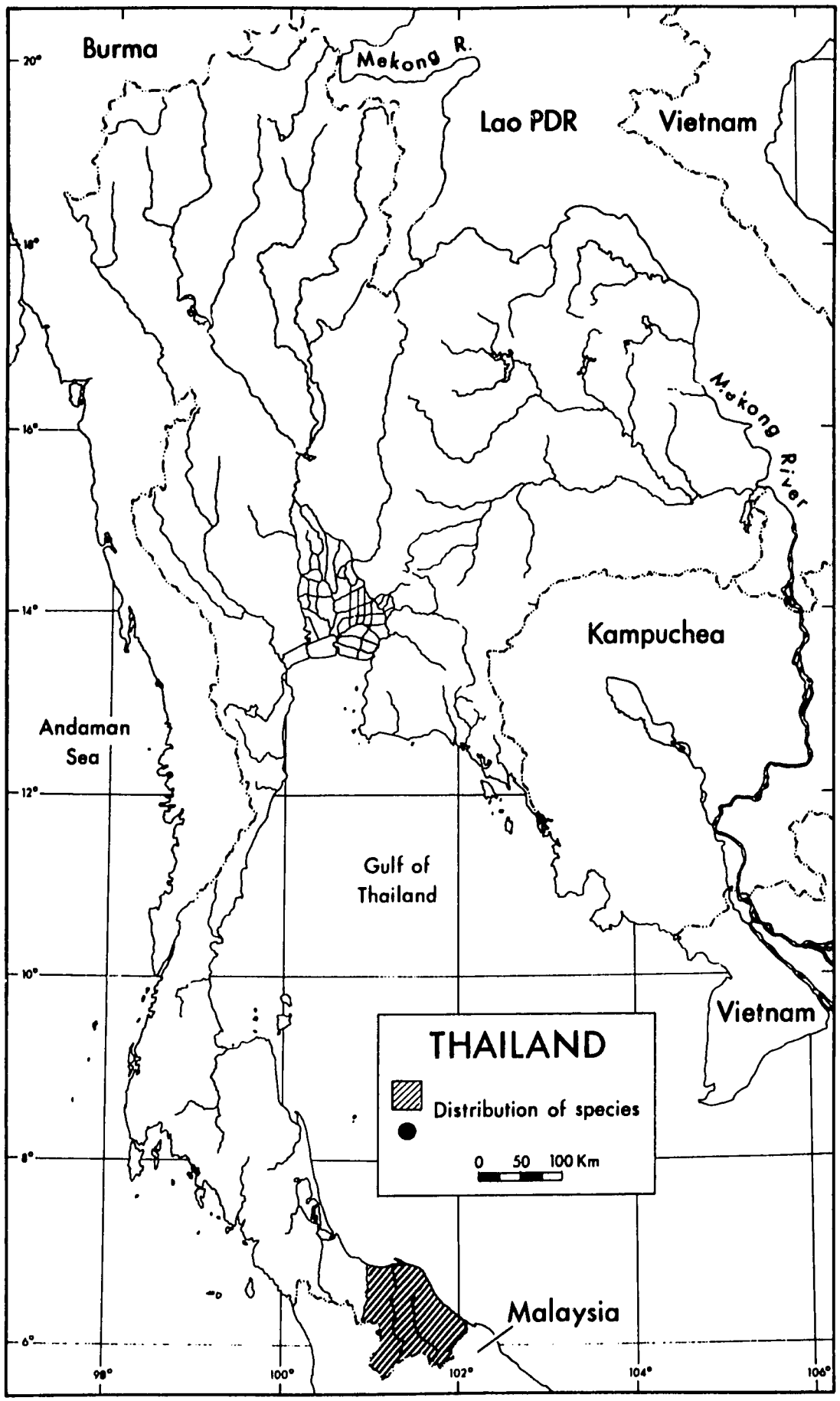
Responses to Habitat Modification: Unknown.

Demographic Characteristics: This species reaches a length of 2.5 m and an age of at least 28 years (Taylor 1965).

Key Behaviors: Blood pythons may be like other pythons in exc, ing physiological control over body temperature (Vinegar et al. 1970).

Conservation Measures Taken: None, although the 30-year strip rotation system recently mandated for mangrove harvest may help this species.

Conservation Measures Proposed: The range and habitat of blood pythons in Thailand are restricted enough that field survey work may provide information on distribution and status, and population monitoring may be feasible. If this is not attempted or successful, a quota system as proposed for the Burmese python should be put into operation.



Python curtus

Spot-billed pelican

Pelecanus philippensis Gmelin 1789

Aves, Pelicaniformes, Pelicanidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: Unknown.

Distribution and History of Distribution: The spot-billed pelican occurs in India, Pakistan, Bangladesh, Sri Lanka, Burma, Thailand, Kampuchea, Lao PDR, southern and eastern China, Hong Kong, Hainan, peninsular Malaysia, Sumatra, Java, and the Philippines. In Thailand the historical range includes the larger marshes of the Chiang Rai-Chiang Saen area and the central plains, the southeastern coast, and both coasts of the peninsula (Deignan 1963, Ali and Ripley 1969, King and Dickinson 1975, Medway and Wells 1976). Current distribution appears to be undocumented. Two individuals were seen at the Chiang Rak Dam, Pathum Thani, in 1977 (Pauley 1977).

Geographical Status: Thailand is central in the species' range.

Habitat Requirements and Habitat Trend: Spot-billed pelicans feed in marshes, freshwater lakes, brackish lagoons, tidal creeks, and estuaries. Nesting is in large trees in swamp forest or swampy savanna (Smythies 1953, Deignan 1963, Ali and Ripley 1969). Vast areas of marsh and swamp have been drained, cleared, and converted to rice paddies. In 1877 Oates (in Smythies) described a 260 square kilometer Burmese swamp with millions of nesting pelicans and adjutant storks; by 1939 the trees and birds were gone. The diet consists of fish.

Vulnerability of Species and Habitat: Pelicans are vulnerable to eggshell thinning and massive reproductive failure caused by chlorinated hydrocarbons like DDT, which is concentrated in the tissues of carnivorous species eaten by the pelicans. The result is region-wide population declines and extirpation (Schreiber 1980). Pelican nesting habitat is vulnerable to deforestation, and marsh feeding habitat is vulnerable to draining.

Causes of Threat: The species is threatened by use of persistent pesticides and by habitat loss.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch contains 3-4 eggs. Incubation takes 30 days, and fledging occurs about 4 months after hatching (Ali and Ripley 1969). If similar to other pelicans, this species probably reaches sexual maturity in 3-5 years.

Key Behaviors: Nesting is colonial, with the season ranging from October to March in India. Both sexes incubate the eggs and feed the young (Ali and Ripley 1969). The species is only a seasonal visitor in northern Thailand (Deignan 1945) and a vagrant south of Songkhla and Trang (Medway and Wells 1976).

Conservation Measures Taken: Spot-billed pelicans are protected by Thai law (WARPA 1972).

Conservation Measures Proposed: Any existing water bird rookeries in Thailand should be inventoried, and the size of pelican populations should be estimated. Colonies of nesting pelicans should be granted protected status that would assure the future of nesting habitat. Eggshells collected during the period from before 1945 to the present should be studied for evidence of thinning. High pesticide levels in the food chain threaten humans as well as wildlife, and evidence of a problem would mandate changing pest control practices nationwide to use of less dangerous pesticides.

Christmas Island frigatebird

Fregata andrewsi Mathews

Aves, Pelicaniformes, Fregatidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979) : Appendix I.
IUCN Red Data Book (1977): Vulnerable.

Population Size and Trend: Population estimates were 1000-1500 pairs in 1938-40, fewer than 2000 pairs in 1967, and fewer than 1000 pairs in 1965-74 (IUCN Red Data Book 1977). The most recent estimate is a population of fewer than 1000 pairs, with a declining trend (Nelson 1976).

Distribution and History of Distribution: The Christmas Island frigatebird is known to breed only on Christmas Island, south of Java. Nonbreeding individuals range widely over the eastern Indian Ocean and South China Sea, with records from India, Java, Borneo, Malaya, peninsular Thailand, and Hong Kong. The species occurs on both coasts of Thailand south of the Isthmus of Kra. Specimens have been collected on Ko Phuket (Deignan 1963, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976).

Geographical Status: The Thailand portion of the speices' range is on the northern periphery of its distribution, presumably occupied seasonally by nonreproductive birds dispersed from the distant nesting site.

Habitat Requirements and Habitat Trend: Nesting habitat is tall trees behind the golf course and along 3.2 km of shore terrace on Christmas Island. The sea almond tree (*Terminalia catappa*) is preferred for nesting, and nests are always 10 m or more above the ground, either to avoid human nest predation or facilitate flight from the nest. Foraging habitat is the surface of the open sea, up to 1500 km from land during nonbreeding dispersal. The diet is mainly flying fish and squid. A small portion of the diet includes fish stolen in flight from species of diving seabirds, and eggs and nestlings from seabird rookeries of their own and other species (Nelson 1976, IUCN Red Data Book 1977).

Vulnerability of Species and Habitat: Nesting frigatebirds have been taken by humans resident on Christmas Island for many years. The demographic adaptations of frigatebirds make them particularly vulnerable to any

man-caused mortality. Nesting habitat is indirectly threatened by surface mining for phosphate, though the rookery is over low-grade deposits that may never be mined (IUCN Red Data Book 1977). However, the economics of phosphate resources are such that all available deposits are expected to become profitably extractible (H.T. Odum personal communication), unless areas are defined for other reasons as too valuable to be mined.

Causes of Threat: Existing harvest and potential habitat loss threaten this species.

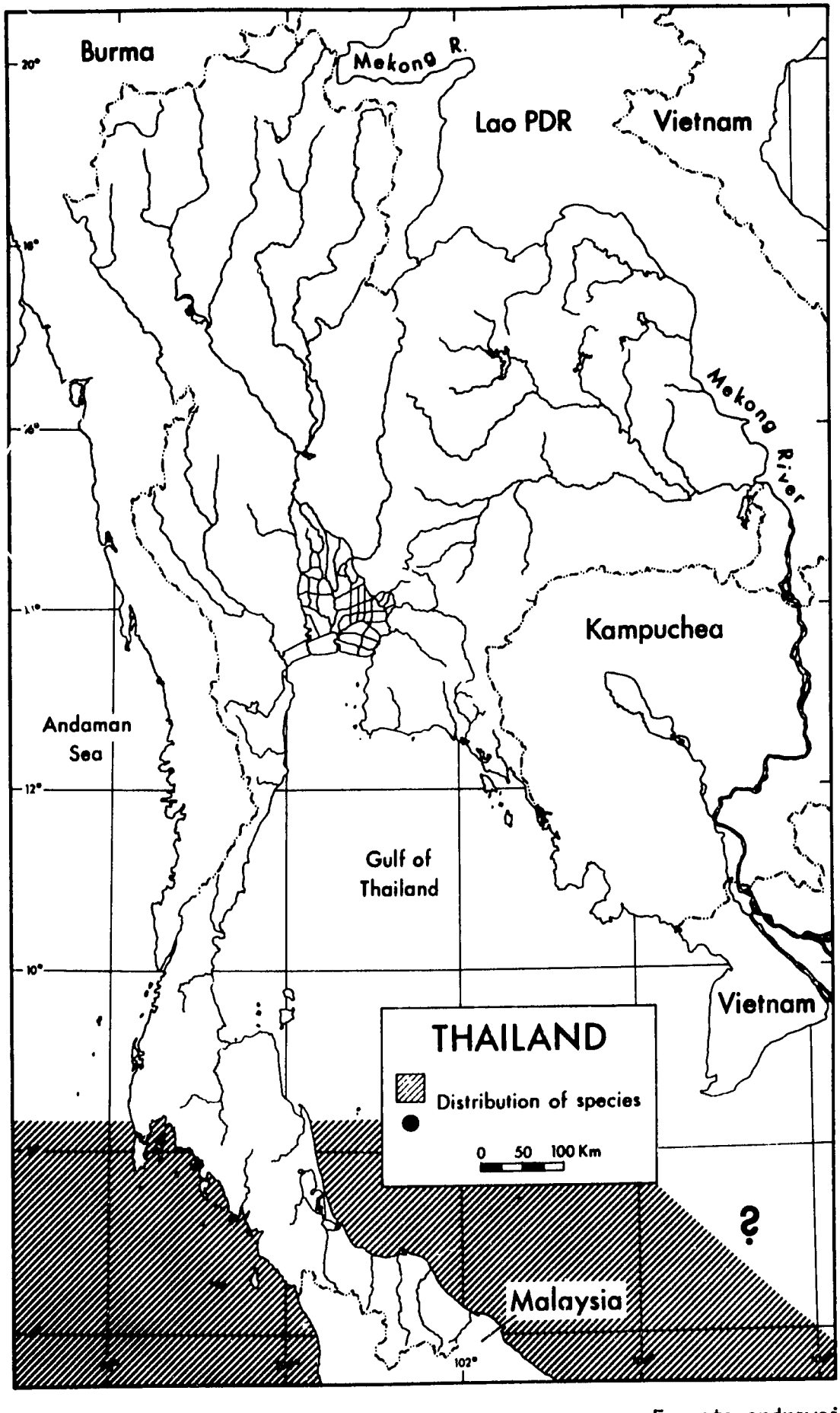
Responses to Habitat Modification: Unknown.

Demographic Characteristics: As in other frigatebirds, the population dynamics of this species are dictated by specialization to use a limited food resource in impoverished seas. The result is low natality, high survival, and a poor ability to respond to population losses. The age at sexual maturity is unknown. Breeding females produce 1 egg every 2 years. The incubation period is about 54 days. The chick grows very slowly, and fledging occurs at about 6 months of age. The parents continue to feed the juvenile for another 9-10 months after fledging. Fledging success is about 30 percent (Nelson 1976). Nelson postulated that mortality during the first year of independence was 20-30 percent, and 4 percent annually thereafter, suggesting a mean life expectancy of 26 years and longevity extremes of 40-50 years; these figures are guesses.

Key Behaviors: The period of egg-laying is April to June. Both parents participate in nest-building and feeding of the young. Bouts of incubation are 2-3 days long, and the simultaneous foraging bouts of the other parent presumably are of the same duration. When the chick is about 45 days old, it is left unattended so that both parents can feed at the same time (Nelson 1976).

Conservation Measures Taken: Frigatebirds are protected on Christmas Island, but the regulation is routinely ignored. A conservation officer was appointed there in 1975 (IUCN Red Data Book 1977).

Conservation Measures Proposed: The steps needed to conserve frigatebirds at the Christmas Island rookery are obvious. Thailand could help by ensuring that the individuals visiting Thai waters and coasts are not killed.



Fregata andrewsi

Chinese egret

Egretta eulophotes (Swinhoe 1860)

Aves, Ciconiiformes, Ardeidae

Status: Endangered.
USFWS 1980a: Endangered.
IUCN Red Data Book (1977): Vulnerable.
IUCN 1979: Threatened.

Population Size and Trend: Population size has never been documented. Formerly a common species, the breeding population of Chinese egrets was decimated by hunting for the plume trade beginning in 1897-98, and by 1925 records of any species of egrets nesting in China were considered noteworthy. The Chinese egret has never recovered its former numbers and remains on the verge of extinction (Murton 1972, IUCN Red Data Book 1977). However, population size and trend on mainland China are unknown. In Hong Kong, 9 pair of Chinese egrets nested in 1959, but that number declined to 3 by 1969 (Murton 1972).

Distribution and History of Distribution: The following account of distribution is taken almost verbatim from the IUCN Red Data Book (1977): The Chinese egret formerly bred in the maritime provinces of Fukien and Kwangtung, China, North Korea, and possibly Cheju Do (Quelpart Island) in the Yellow Sea (La Touche 1931-34, Austin 1948). It was found breeding in Hong Kong in 1956 (Murton 1972). Its present breeding distribution is not well known, but recent specimens in Peking are from Kwangtung, including Hainan, Chekiang, Fukien, Taiwan, Kiangsu, and Shantung (information from Tso-hsin Cheng). Whether the species still breeds in North Korea is unknown. Recent postbreeding records are from Amur-Ussuriland, USSR (regularly in the spring), Taiwan in summer and winter, and other winter records from coastal South Korea, the Ryukyu Islands, Sabah, Malaya, and the Aleutian Islands. Former winter records, when the population was larger, were from the Philippines, Sulawesi, peninsular Thailand, Malaysia, Sarawak, Honshu, Japan, and Natuna Island.

Geographical Status: The Thailand distribution constituted a small part of the Chinese egret's migratory and winter range. The species may no longer frequent Thailand coasts, as the last records occurred in 1901 (Deignan 1963).

Habitat Requirements and Habitat Trend: Foraging habitat in both summer and winter is tidal mudflats and the edge of estuaries (Swinhoe 1860, La Touche 1931-34, Murton 1972). Occasionally individuals are seen

on salt pans, along the seashore, in rice paddies, or along rivers (Courtois 1927, La Touche 1931-34). The diet consists of fish, shrimp, and Squilla (Swinhoe 1860). In both foraging behavior and habitat the Chinese egret is specialized in the same ways as its North American ecological equivalent (Murton 1972), the reddish egret (Dichromanassa rufescens). Nesting habitat is in rookeries in trees, shared with many other species of herons and egrets. In Hong Kong, the number of rookeries is declining, from 9 in 1959 to 3 in 1969 (Murton 1972).

Vulnerability of Species and Habitat: Currently the species is not vulnerable to man-caused losses, but its nesting habitat is being impacted by human disturbance and land-use encroachment. In the past, the species was highly vulnerable to hunting for commerce in feathers, drastically reducing the total population. The Chinese egret is the central member of a 3-species guild, each weakly displaced in space, with marine habitat occupied by the reef egret (Egretta sacra) and freshwater habitat by the little egret (Egretta garzetta), each exhibiting some overlap in foraging habitat. Following the heavy harvest of egrets, the population of Chinese egrets became very small, and competition from its more abundant guild neighbors may explain the failure of this species to recover its former numbers (Murton 1972).

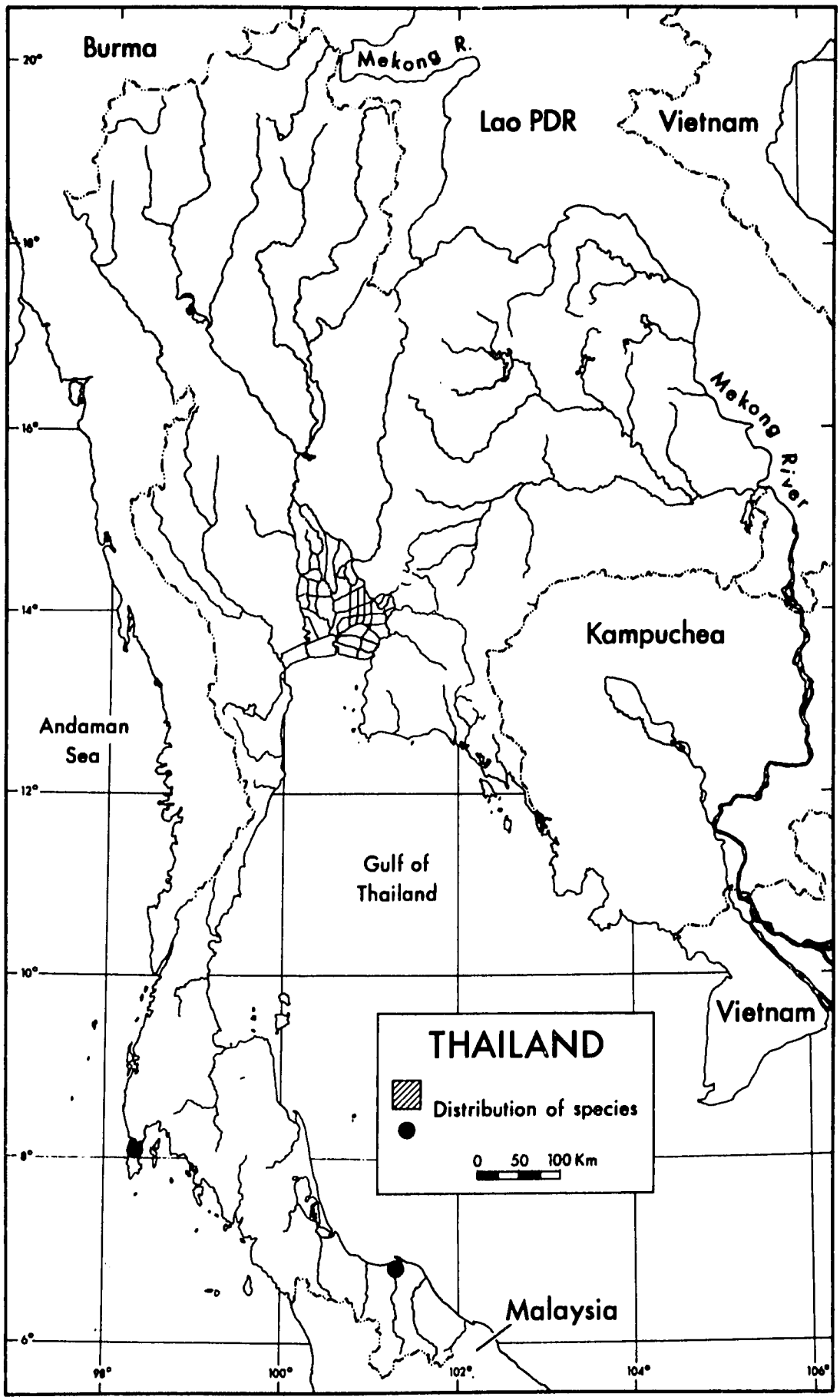
Causes of Threat: Currently disturbance and destruction of rookeries is a serious threat to the remaining Chinese egrets (Murton 1972). What threats may prevail on mainland China are unknown.

Demographic Characteristics: A clutch may contain 3 eggs (Rickett 1903). In Hong Kong, eggs are laid in late April, and the young hatch in late May, with incubation taking about 29 days (Murton 1972).

Key Behaviors: In the Malay Peninsula, migratory Chinese egrets have been observed between 14 August and 26 April (Medway and Wells 1976). This species hunts by "parasolling"--spreading and flicking its wings to frighten fishes from cover and running after them to attempt capture (Murton 1972).

Conservation Measures Taken: Mostly unknown. The remaining rookeries in Hong Kong are policed by game wardens (Murton 1972).

Conservation Measures Proposed: Nothing can be done in Thailand to enhance the survival of this species. Conservation steps should focus on the breeding range, once information on its extent and problems are known.



Egretta eulophotes

Painted stork

Ibis leucocephalus (Pennant)

Aves, Ciconiiformes, Ciconiidae

Status: Endangered.
IUCN (1968): Threatened.

Population Size and Trend: In the past, painted storks were locally common in much of their range, including India, Burma, southern and eastern China, and peninsular Thailand (Ali and Ripley 1968, Smythies 1953, La Touche 1931-34, Glenister 1955, Robinson 1915 in Riley 1938). However, it was considered uncommon by Lekagul and Cronin (1974). At present, the only breeding population known in Thailand consists of 4 nesting pairs (Robert Dobias personal communication). Several times this number occurs in zoos in Bangkok and Samut Prakan (our observations).

Distribution and History of Distribution: Painted storks occur in lowlands from Sri Lanka and India east to Vietnam, eastern China, and Hainan, and from southern China to the island Pulau Langkawi just south of the Thai-Malaysian border (La Touche 1931-34, Riley 1938, Glinster 1955, Smythies 1953, Ali and Ripley 1968, King and Dickinson 1975, Wildash 1968). Whether the range has become smaller is uncertain. Only one rookery is known in Thailand, in the Melaleuca swamp north of Thale Noi (Robert Dobias personal communication). About 30 painted storks stayed at Wat Phai Lom, Changwat Pathum Thani, for a few days in November 1980 (Pilai Poonswad personal communication). A bird that may have been this species was reported to have been shot and eaten in 1978 at a village on the floodplain south of Khao Yai National Park, on Klong 31, Changwat Nakorn Nayok (Virach Chantrasmi personal communication).

Geographical Status: The Thailand distribution is central within the species' range.

Habitat Requirements and Habitat Trend: Foraging habitat is in marshes, flooded rice paddies, wet savannas, and riverine and coastal mudflats (La Touche 1931-34, Smythies 1953, Ali and Ripley 1968, Wildash 1968). Nesting habitat is in large trees that grow in or next to water (Ali and Ripley 1968, Robert Dobias personal communication). The diet consists mainly of fish, plus reptiles, frogs, crustaceans, and insects (Ali and Ripley 1968).

Vulnerability of Species and Habitat: The species is highly vulnerable to nest-robbing and destruction of rookery habitat. Because the known population is so small, it also is vulnerable to

chance occurrence of a series of drought years in which conditions fail to support reproduction. Drainage of marsh habitats around Thale Noi presumably would cause extirpation of the painted stork from Thailand.

Causes of Threat: All nesting painted storks that do not die of natural causes or are not taken into captivity by Wildlife Conservation officials are taken from the nests by people. The current price for a nestling in Nakhan Si Thammarat is US $100 (Robert Dolbias, personal communication). Painted storks exported from Thailand numbered 2 in 1967 and 8 in 1971 (Royal Forestry Department 1972). Hence the captive-rearing program of the Royal Forestry Department is the only force now slowing the imminent extirpation of this species from Thailand.

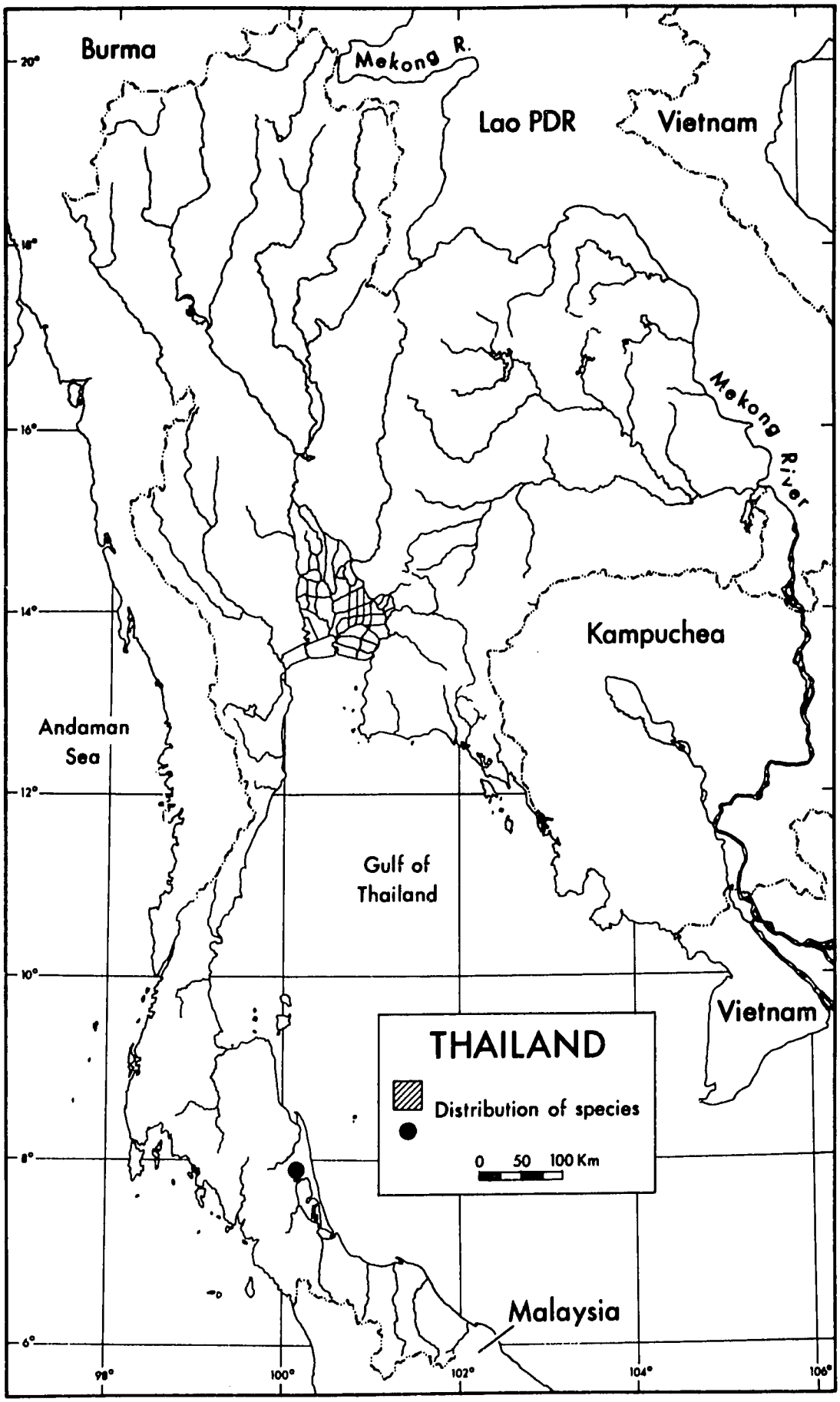
Responses to Habitat Modification: Unknown. Though painted storks use rice paddies when flooded, reproduction and seasonal distribution of the species are controlled by the temporal and spatial effects of flooding on food supply. Therefore it cannot be assumed that rice paddies developed in place of marsh habitat will continue to supply an adequate abundance and distribution of stork food. Any such negative effects would have disastrous impact if the habitat around the rookery were to be modified.

Demographic Characteristics: The clutch ranges from 2-5 eggs and is usually 3-4 (Ali and Ripley 1968). Other features are undocumented.

Key Behaviors: The species is non-migratory but shifts its residence according to water conditions. Timing of the nesting season depends on the weather. Reproduction fails during drought years. Rookeries that are seldom disturbed and achieve a replacement rate of reproduction are used annually and hence are very important to the species (Ali and Ripley 1968). Reproduction at the Thale Noi rookery occurs in the hot season (Robert Dobias personal communication).

Conservation Measures Taken: Several management practices favor the tenuous existence of Thailand's painted stork population. Thale Noi is designated as a No-hunting Area, and Wildlife Conservation officials are stationed there. Trees are protected from harvest to prevent deforestation of the Thale Noi swamp. The healthy fishing economy depends on the shallow lake, favoring current land use practices. Succession of the lake into marshland is slowed by protecting the fringing swamp forest, which serves as a nutrient trap that helps stabilize the present human economy. The practice of hand-rearing some of the painted stork nestlings at the Wildlife Conservation office has resulted in the only successful recruitment of subadults into the wild in recent years.

Conservation Measures Proposed: Extension of the Non-hunting Area provisions to the swamp forest around Thale Noi would give the small painted stork population the full benefit of its reproductive effort. Failing that, conservation officials should undertake a more intensive captive-rearing program, leaving 1 nestling in each nest to ensure that the rookery will not be abandoned. If international trade can be shown to contribute to the market demand, the painted stork should be protected under WARPA (1972). Reproductive success and long-term survival of rookery birds should be studied annually, and emergency measures should be instigated at the first indication of any downward trend. It would be appropriate to investigate the potential for reintroduction of zoo-held painted storks to supplement the Thale Noi population.



Ibis leucocephalus

Openbilled stork

Anastomus oscitans (Boddaert)

Aves, Ciconiiformes, Ciconiidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: The Wat Phai Lom population of openbilled storks was estimated at 22,000 by Lauhachinda (1969). In 1980 the population was estimated at 30,000 based on a count of nests and assuming 3 fledged young per nest and an equal sex ratio of adults. Hence about 6000 breeding females are indicated. Other Thai populations total 200-1000 individuals (Taweesak Trirawatpong personal communication). Annual nest counts in January by the Bangkok Bird Club, plus 20 percent to account for poor visibility in the thick bamboo groves, have shown a steady population increase from 1978 to 25,000 adults in 1980 but a reduction to 17,700 in 1981. Assuming 2 fledged young per nest and . nest for every 2 adults, the population in June 1981 was calculated to be 35,400 adults and fledged young (Virach Chantrasmi personal communication).

Distribution and History of Distribution: The openbilled stork occurs in Pakistan, India, Sri Lanka, Nepal, Bangladesh, Burma, Thailand, and Kampuchea (Ali and Ripley 1968, King and Dickinson 1975). In Thailand the species occurs in three rookeries. The major one is at Wat Phai Lom, Changwat Pathum Thani across the Mae Nam Chao Phraya from Sam Khok. New rookeries, perhaps 2-3 years old, are occupied by 100-1000 storks at Suphan Buri and 100 storks at Ban Po Rajaburi (Taweesak Trirawatpong personal communication). Birds from the rookeries disperse widely to forage. During dispersal and migration they may be found in appropriate habitat throughout the country as far south in the peninsula as Krabi (Deignan 1963, Lekagul and Cronin 1974).

Geographical Status: The Thai portion of the range is a central part of the total distribution and is linked with distribution in other countries because of seasonal habitat requirements.

Habitat Requirements and Habitat Trend: The original foraging habitat of openbilled storks in Thailand is presumed to have been marshland, most of which has been converted to agricultural uses. The storks now feed in wet rice fields and on the edge of canals and rivers. Nesting habitat is groves of large trees and bamboo where large arboreal predators are relatively few. The diet consists mainly of apple snails--*Pila globosa* in India, *P. pesmei* and *P. ampullacea* in Thailand--plus crabs, frogs, and other small marsh animals (Ali and Ripley 1968, McClure and Kwanyuen 1973, Poonswad 1979). Wet season habitat is in the Brahmaputra and Ganges deltas of Bangladesh.

Vulnerability of Species and Habitat: The species is highly vulnerable to vandalism and habitat destruction at the three rookeries that sustain the Thai population. In 1970, poachers used slingshots to kill several hundred storks at Wat Phai Lom, and the disruption nearly caused abandonment of the rookery (McClure and Kwanyuen 1973). The adult birds tolerate people walking through the rookery, but many young disturbed by such activity fall from the nests and subsequently die. Foraging habitat is vulnerable to drainage, but conversion of native marsh to artificial rice marsh is not a threat. Proper distribution and abundance of apple snails are essential to maintain the stork population.

Causes of Threat: Unknown, but the vulnerability of any species concentrated at one site is alarming. Marshes everywhere are disappearing. No information is available on the biology of the species or its habitat during the wet season. Birds soaring on thermals above the Wat Phai Lom rookery are a potential hazard to commercial aircraft, and a tragic accident probably would lead to destruction of the colony. The conflict involves jets originating in Europe and approaching the Don Muang Airport, Bangkok, via Burmese airspace from late February through early December, when the prevailing wind is from the south or southwest (Virach Chantrasmi personal communication).

Responses to Habitat Modification: Openbilled storks adapt to feeding in rice fields after marshes have been converted to agriculture. The biology of apple snails in rice paddies has not been studied, but snail distribution and abundance in paddies appear sufficient to support stork reproduction. When rookery trees die from excessive bird-dropping fertilizer, the storks shift to bamboo and any available support for nests. To the extent that nests, eggs, and young are more easily dislodged by winds, the recruitment rate of fledged young decreases due to nest failure once the large trees die. When new trees are planted adjacent to the rookery, the storks soon use them for nesting. With nesting space apparently a limiting factor, the impact of reducing the rookery area for human development would presumably be negative.

Demographic Characteristics: The normal clutch consists of 4 eggs, but usually only 2 young survive to fledge, except in years without wind storms. Eggs are laid at about 2-day intervals, and hatching is at 27-29 days. Flight is possible after 40 days, but parental care can last for 2 months (Lauhachinda 1969, in McClure and Kwanyuen 1973).

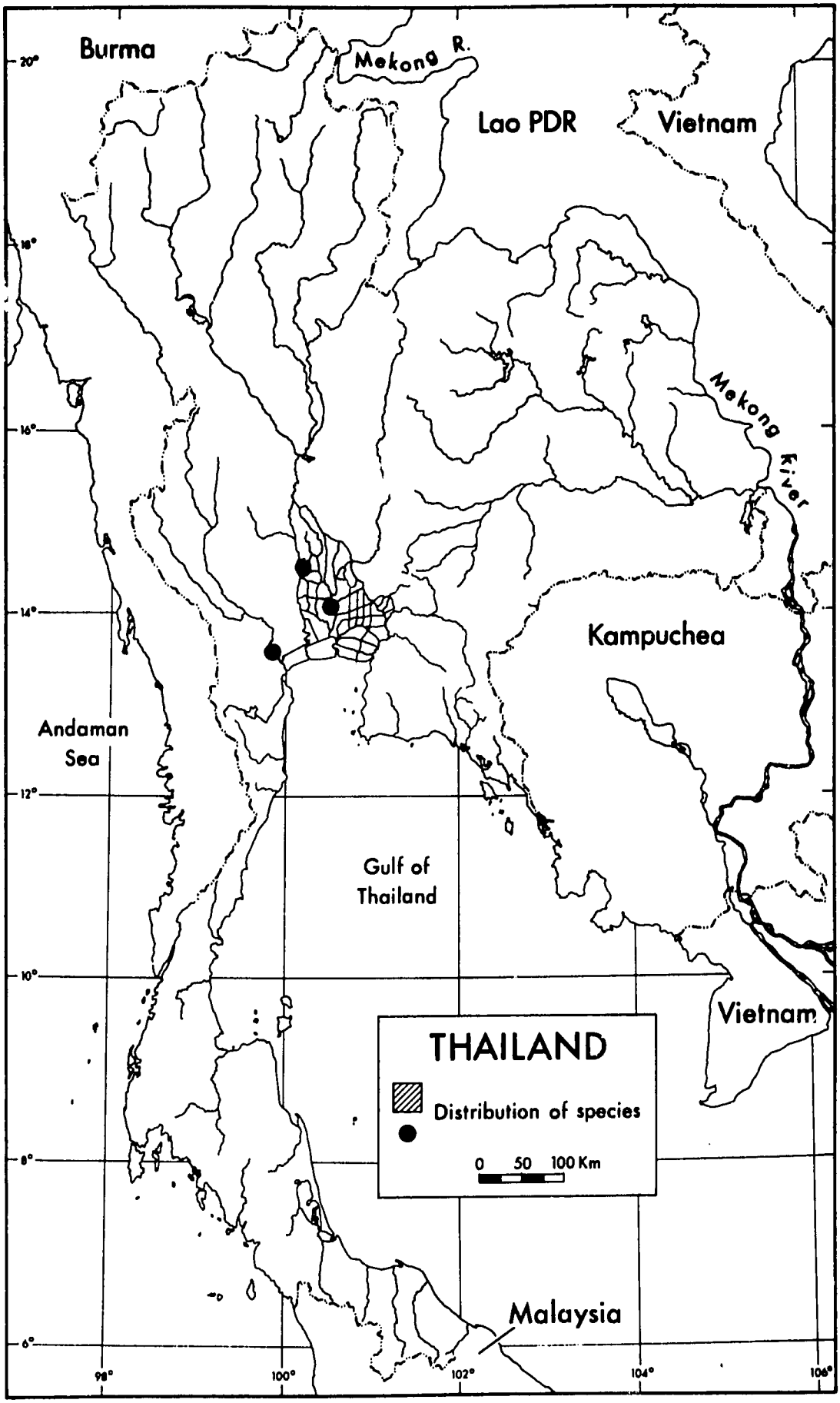
Key Behaviors: Openbilled storks are annual migrants, arriving at Wat Phai Lom in October and November. The colony begins to disperse in April and May, and only a few hundred birds remain resident in the wet season (Lauhachinda 1969). Dispersal takes some birds to northern Thailand and a few to Kampuchea, but most migrate about 1500 km to Bangladesh, living in the deltas of the Brahmaputra and Ganges rivers (McClure 1974).

Birds disperse daily up to 80 km from Wat Phai Lom to forage (McClure and Kwanyuen 1973). The bill is specialized for holding and opening apple snail shells. Returning parents regurgitate snail meat into the nest for nestlings to eat, and much meat drops to the ground and is used

by fledglings and adults. Nesting during the dry season, when food is concentrated in the remaining flooded areas, enables foraging at a level of efficiency that will support reproduction.

Conservation Measures Taken: Openbilled storks are protected by the Wild Animals Reservation and Protection Act of 1972, which prohibits hunting and allows export only with special permission from the Wildlife Advisory Committee of the Wildlife Conservation Division. Wat Phai Lom has been designated as a Non-hunting Area. A large portion of the Wat Phai Lom rookery on which the trees had died has been replanted by the Royal Forestry Department, and the young trees are in use for nesting. Establishment of a new colony has been attempted by introducing 60 fledglings from Wat Phai Lom at a wildlife sanctuary in Changwat Surat Thani; in 1980, 10 subadults remained there (Virach Chantrasmi personal communication).

Conservation Measures Proposed: The excellent protection of the stork rookery at Wat Phai Lom should be maintained and extended to the two new colonies. The Wildlife Conservation Division may in the future find it appropriate to work with the monks of Wat Phai Lom and neighbors to prevent human encroachment on nesting habitat. Signs and fences should be erected at the rookeries to prevent visitors from walking into the rookery areas, because such disturbance frightens the birds and leads to mortality of young (Pilai Poonswad personal communication). Because an aircraft accident involving soaring Wat Phai Lom storks probably would stimulate destruction of the colony, it would be very helpful to conduct a study of horizontal and vertical distribution and timing of soaring birds, for the purpose of recommending altered aircraft approach time or routes to the Don Muang Airport. To establish a number of rookeries, introductions like that at Surat Thani should be made nationwide at Wildlife sanctuaries and national parks that have suitable habitat (Virach Chantrasmi personal communication). It would be useful to exchange information with wildlife officials in Bangladesh as a way of encouraging the well-being of this migratory species.



Anastomus oscitans

Black stork

Ciconia nigra (Linnaeus)

Aves, Ciconiiformes, Ciconiidae

Status: Threatened.
CITES (1979): Appendix II.
WARPA (1972): Rare.

Population Size and Trend: Unknown.

Distribution and History of Distribution: The black stork breeds from Sweden, Denmark, and Germany east through Russia and northern China, Korea, and Japan, in the Middle East including Turkey, Iran, Afganistan, and Pakistan, and in southern Africa. It winters in Africa and southern Asia, including the lower Yangtse River basin and southeastern Yunnan Province, China, India, Burma, and northern Thailand, northern Lao PDR, and northern Vietnam (La Touche 1931-34, Deignan 1945, Smythies 1953, Ali and Ripley 1968, Tarboton and Cardwell 1968, Gore and Pyong-Oh 1971, King and Dickinson 1975). In Thailand the black stork has been reported in winter from Chiang Rai and on the Mekong between Ban Nam Khuang and Huai Sai, Lao PDR (Deignan 1945, 1963).

Geographical Status: The breeding range of this species is Palearctic, and in Thailand it occurs only as a vagrant. Whether the Chiang Rai marshes once were a regular wintering ground can never be known.

Habitat Requirements and Habitat Trend: This is a bird of marshes, rivers, and other freshwater wetlands. The species often feeds on the edges of small wooded streams or pools (Kahl 1972). It feeds on frogs, fish, insects, crustaceans, rodents, and small birds (Ali and Ripley 1968). Nests are built in tall trees or on high cliffs (La Touche 1931-34, Ali and Ripley 1968, Tarboton and Cardwell 1968).

Vulnerability of Species and Habitat: The species is very wary (Ali and Ripley 1968) but is vulnerable in rookeries. Its habitat is vulnerable to drainage and conversion to agricultural uses.

Causes of Threat: Unknown.

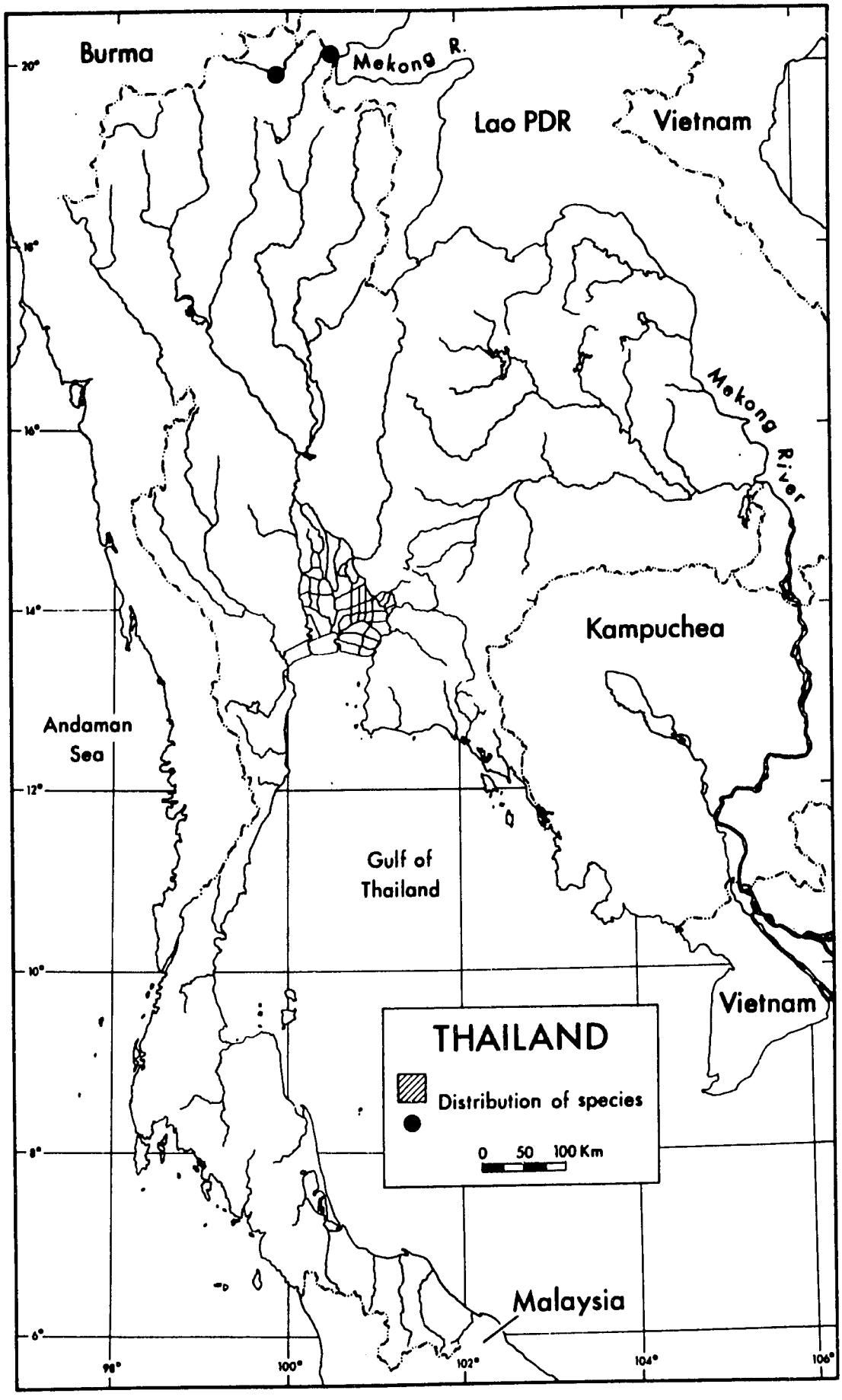
Responses to Habitat Modification: Unknown.

Demographic Characteristics: A clutch contains 3-5 eggs (Ali and Ripley 1968), but usually only 1 or 2 chicks are raised because attacks among siblings result in early deaths (Tarboton and Cardwell 1968).

Key Behaviors: Migration occurs between breeding and winter range. The species often forages in association with the white-necked stork, *Ciconia* (*Dissoura*) *episcopus*, a fact probably important to the feeding ecology of both species.

Conservation Measures Taken: The black stork is protected by the Wild Animals Reservation and Protection Act of 1972, which prohibits hunting and allows export only with special permission from the Wildlife Advisory Committee of the Wildlife Conservation Division.

Conservation Measures Proposed: Little done in Thailand can be relevant to the needs of this species. However, its history should be considered in evaluating wetlands that remain around Chiang Rai.



Ciconia nigra

White-necked stork

Cionia (Dissoura) episcopus (Boddaert 1783)

Aves, Ciconiiformes, Ciconiidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: Unknown in Thailand; early author's reports show the species was widespread and perhaps common (Ripley 1938, Deignan 1945), but now it is rare (Lekagul and Cronin 1974). In Sri Lanka, white-necked storks have been greatly reduced in number (Henry 1971), and the subspecies occupying peninsular Malaysia, Sumatra, and Borneo has become rare (IUCN Red Data Book 1979).

Distribution and History of Distribution: This species occurs discontinuously throughout tropical Africa and Asia. Records in Thailand were numerous early in this century. Riley (1938) cited records from Changwat Trang (Prahmon, Tyching, Lay Long Hong), the Tenasserim area (Bok Pyin, Champang, Tanjong Badak), Patani, Trang, Surat Thani, Ko Samui, Nong Kok, Ghirbi, Ratchaburi, Phetburi, the Khorat Plateau (Sakerat and Muang Pai), Tha Law, Hat Sanuk, Koh Lak, on the Mae Nam Mae Ping, and Chaing Saen. Deignan (1945) reported white-necked storks widely over the plains of Chaing Rai, at Fang, north of Wiang Pa Pao, on the plains between Thoeng and Chiang Rai, and on the marsh at Mae Chai. Meduay and Wells (1976) reported a breeding colony in northeastern Changwat Songkhla and a record at Phuket. Ogle (1974) reported birds 2 km northeast of Chanthaburi in December of 1971 and 1972.

Geographical Status: Thailand is central to the Asian part of species' range.

Habitat Requirements and Habitat Trend: The white-necked stork forages in a wide variety of habitats, including streams in primary forest, edges of major rivers, swamps, wet or dry marshes, rice paddies, dry fields, plains, freshly burned lalang (Imperata) grass, and exposed coral reefs. However, it most often uses clay sites (Deignan 1945, Smythies 1953, Hoogerwerf 1969, Kahl 1972). Nesting is in trees in deep forest, usually in single nests or small rookeries (Smythies 1953, Kahl 1972). The diet includes crabs, fish, frogs, molluscs, and many grasshoppers (Riley 1938, Henry 1971).

Vulnerability of Species and Habitat: Any large, conspicuous species like this is vulnerable to shooting, especially when nesting. Deforestation is considered to be a major threat to the subspecies *C. e. stormi* in Borneo (IUCN Red Data Book 1979).

Causes of Threat: Undocumented in Thailand.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch contains 3-4 eggs (Smythies 1953).

Key Behaviors: The nesting season appears to be quite variable, ranging from September to June in Burma (Smythies 1953). Both members of the pair feed the young by regurgitating food onto the nest floor. Foraging is done at a slow walk, and prey are located visually (Kahl 1972). Most authors consider the species to be a permanent resident in Thailand, though Glenister (1955) termed it a winter visitor. Individuals have been seen in all months in peninsular Thailand (Medway and Wells 1976). Some populations in Africa are migratory or partly so (Elgood 1973).

Conservation Measures Taken: This species is legally protected in Thailand, Indonesia, and Sarawak (WARPA 1972, IUCN Red Data Book 1979).

Conservation Measures Proposed: A survey of the status of the white-necked stork in Thailand is needed to provide a basis for planning conservation measures.

Black-necked stork

Xenorhynchus asiaticus (Latham 1790)

Aves, Ciconiiformes, Ciconiidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: The species is uncommon throughout its range (Deignan 1945, Ali and Ripley 1968, Henry 1971, Lekagul and Cronin 1974). It was seen relatively frequently in the early part of this century, but it is seldom reported now, with the last published sighting in 1971 (Deignan 1945, Ogle 1974).

Distribution and History of Distribution: The range of the black-necked stork includes India, Pakistan, Bangladesh, Sri Lanka, Nepal, Burma, Thailand, Lao PDR, Kampuchea, southern Vietnam, peninsular Malaysia, New Guinea, and Australia (Gibson-Hill 1949, Ali and Ripley 1968, Wildash 1968, King and Dickinson 1975). Published records in Thailand are as follows: near Chiang Saen in August 1914, in May 1936 at Mae Chai and on the plains near the Nam Ing between Thoeng and Chaing Rai, and in January 1939 on the Mekong about 20 km below Ban Huai Sai (Deignan 1945); breeding on the north side of the Telibun Straits, Changwat Trang, and occurring widely in northern peninsular Thailand (Robinson and Chasen 1936); and flying high about 2 km northeast of Chanthaburi in February 1972 (Ogle 1974).

Geographical Status: Thailand is central in the species' range.

Habitat Requirements and Habitat Trend: The black-necked stork inhabitats marshes, swamps, lakes, large rivers and adjacent plains, and mangrove swamps. A pair builds an enormous nest of sticks 20-25 m high in a tree, which may be distant from foraging areas. Nesting in India is in September to December, depending on when the rains cease. The diet is mainly fish but also includes frogs, reptiles, and crabs (Ali and Ripley 1968, Lekagul and Cronin 1974, King and Dickinson 1975). The wetlands of Thailand have been reduced to small remnants.

Vulnerability of Species and Habitat: The species "is very wary, flying off...at the first sign of approach of its arch-enemy, man" (Henry 1971). Its habitat is vulnerable to deforestation, drainage, and conversion to agricultural uses.

Causes of Threat: Shooting and habitat loss threaten the black-necked stork.

Responses to Habitat Modification: Unknown. Unmolested birds will nest in trees left in cultivated areas (Ali and Ripley 1968).

Demographic Characteristics: The clutch contains 3-4 eggs, or rarely 5 (Ali and Ripley 1968).

Key Behaviors: This species occurs alone, in pairs, or in small groups of adults and their young. Pairs appear to have clearly defined activity ranges, and nesting is solitary. Both members of the pair build the nest and feed the young by regurgitating food onto the nest floor. Most food is located by slowly walking and probing in the water and submerged vegetation, but occasionally the birds run a few steps in pursuit of prey. Like other storks, this species soars and circles high in the sky during the rest of the day. The black and white pattern under the wings is used in pair-bonding displays (Ali and Ripley 1968, Kahl 1973).

Conservation Measures Taken: This species is protected under Thai law (WARPA 1972).

Conservation Measures Proposed: A survey of wetland habitat and a survey of the status of black-necked stork populations are needed as first steps in planning a conservation program. Education is needed to teach the public that molesting these rare animals will lead to their extirpation.

Greater adjutant stork

Leptoptilos dubius (Gmelin)

Aves, Ciconiiformes, Ciconiidae

Status: Threatened.
IUCN (1968): Threatened.

Population Size and Trend: Unknown. The greater adjutant stork is becoming rare in Thailand (Lekagul and Cronin 1974), and no breeding colonies are known in the country. The "vast armies" of greater adjutants that formerly congregated in southern Burma to breed (Hume and Oates 1890) no longer do so (Smythies 1953). "It has been suggested that the Indian adjutants probably all migrate to this area to nest" (Ali and Ripley 1968).

Distribution and History of Distribution: This species is known from India, Bangladesh, central and southern Assam, southern Burma, Thailand except the Malayan Peninsula, southern Lao PDR, Kampuchea, and southern Vietnam (Ali and Ripley 1968, King and Dickinson 1975). The two rookeries and "incredible" numbers (Hume and Oates 1860) that arrived in southern Burma during October for the breeding season no longer occur (Smythies 1953). Ali and Ripley (1968) note an 1883 report by Baker that 40-50 pair of greater adjutants had nested for years at a spot in the Sundarbans of Bangladesh. No current sites of breeding are reported for the species. The range in Thailand was given as "The broader rivers and more extensive marshes of the northern plateau (Chiang Rai, Phayao), the southeastern provinces (Chon Buri), and of the central plains (Deignan 1963)."

Geographical Status: Thailand is central in the species' original range, but whether it did or does support breeding is unknown.

Habitat Requirements and Habitat Trend: The greater adjutant stork occurs on open plains, wet savannas, marshes, lake edges, rice paddies, and open forest (Deignan 1963, King and Dickinson 1975), "particularly where the water is drying and concentrating the fish life in shallow puddles" (Ali and Ripley 1968). One nesting site in Burma was described as in trees on inaccessible cliffs along the Ataran River (Smythies 1953). The Sundarbans rookery was in "lofty trees in dense forest on the edge of a vast area of swamp and lake" (Ali and Ripley 1968). This carnivorous species eats carrion, fish, frogs, snakes, and crustaceans. The storks feed among kites and vultures on dead animals near villages, and used to scavenge regularly in Calcutta in the days when municipal sanitation was minimal (Ali and Ripley 1968).

Vulnerability of Species and Habitat: Native habitat is vulnerable to drainage and conversion to agricultural uses.

Causes of Threat: Unknown. Deignan (1945) reported the greater adjutant as so wary as to be unapproachable by hunters. This is likely to be untrue in rookeries. Annual exports from Thailand in 1969 and 1970 were 4 and 2 (Royal Forestry Department 1972). Clearly most marsh and wet savanna habitat has been lost.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch contains 2-4 eggs, usually 3 or 4 (Ali and Ripley 1968).

Key Behaviors: Both sexes participate in nest building and incubation (Ali and Ripley 1968). The greater adjutant is widespread in southern Asia during the nonreproductive season from about April to November, when nomadic movements are determined by hot season and monsoon water levels. The birds migrate to breeding areas, which are occupied from about October to March. Breeding begins with the cessation of the rains, and young are reared as water levels diminsh, concentrating marsh animals in pools (Smythies 1953, Ali and Ripley 1968).

Conservation Measures Taken: None.

Conservation Measures Proposed: An inventory of the wetlands remaining in Thailand is needed to determine what greater adjutant habitat is left in the country. A status survey and field study of this species are needed to determine population levels and to learn more of its basic biology. A search for rookeries should be undertaken cooperatively among southern Asian nations, perhaps to be begun by correspondence, with the ultimate goal being to develop international conservation measures to ensure the survival of the species.

Lesser adjutant stork

Leptoptilos javanicus (Horsfield)

Aves, Ciconiiformes, Ciconiidae

Status: Threatened.

Population Size and Trend: Unknown. The lesser adjutant stork once was common over most of its range, often referred to as the most abundant species of stork (Glenister 1955, Wildash 1968, Hoogerwerf 1969, Medway and Wells 1976, Storer 1977). However, it has "declined in numbers during the present century" and is now scarce where it was common (Medway and Wells 1976). At Thale Noi, Thailand, where this species formerly was common, Storer (1977) saw one in 6 months, and eight individuals were present in 1980 (Robert Dobias personal communication). Two were seen soaring over Khao Yai National Park in January 1979 (Boonsong Lekagul personal communication).

Distribution and History of Distribution: The species ranges from Sri Lanka, India, Nepal terai, Assam, Bangladesh, Burma, southern China, Indochina, Hainan, Thailand, Malaysia, Borneo, Sumatra, and Java (Riley 1938, Ali and Ripley 1968, Medway and Wells 1976). Lesser adjutants occurred throughout southwestern and peninsular Thailand, with specific records from south of Rat Buri, Ko Lak, Ko Naka Yai near Phuket, Chumphon, and Lay Song Hong and Prahmon in Changwat Trang (Riley 1938), plus Thale Noi.

Geographical Status: Thailand is north-central in the species' range.

Habitat Requirements and Habitat Trend: The lesser adjutant appears to be most common in mangrove and Melaleuca swamps, on coastal mudflats, and at the mouths of rivers, but it also occurs in rice paddies, dried-up swamps, recently burned plains, and pools in the forest. Breeding is in rookeries in very tall trees, but some nests are scattered singly in the forest. The diet consists of fish, frogs, reptiles, crustaceans, and insects, but not carrion (Glenister 1955, Ali and Ripley 1968, Hoogerwerf 1969, Medway and Wells 1976).

Vulnerability of Species and Habitat: The species is reputed to be very wary but is vulnerable to human nestling-stealers in rookeries. Annual exports from Thailand from 1969 to 1971 were 2,4, and 23 (Royal Forestry Department 1972). Much of the mangrove swamp of Thailand has been cleared or reduced to young stands by cutting for charcoal, and much wetland habitat has been drained or converted to agricultural use.

Causes of Threat: Unknown.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch contains 3-4 eggs (Smythies 1953, Ali and Ripley 1968).

Key Behaviors: Nesting occurs in November to January in India (Ali and Ripley 1968) and August to October in Java (Hoogerwerf 1969). The species is considered nomadic and locally migratory (Ali and Ripley 1968).

Conservation Measures Taken: None.

Conservation Measures Proposed: An inventory of the wetlands remaining in southwestern and peninsular Thailand is needed to determine what lesser adjutant habitat is left in the country. A status survey and field studies of this species are needed to determine population levels and to learn more of its basic biology. That new information is needed for planning conservation measures.

White ibis

Threskiornis melanocephala (Latham 1790)

Aves, Ciconiiformes, Threskiornithidae

Status: Threatened.

Population Size and Trend: The white ibis was once an uncommon but regular member of the Thailand avifauna (Lekagul and Cronin 1974), but it had not been seen in recent years until 2 populations were found in 1978 and 1979 (Virach Chantrasmi personal communication). In the Malay Peninsula, numbers have declined in recent decades (Medway and Wells 1964). The species was considered abundant in portions of its range in Burma (Smythies 1953) and southern Vietnam (Wildash 1968).

Distribution and History of Distribution: The species is widespread in southern Asia, India, Pakistan, Bangladesh, Nepal, Sri Lanka, southeastern China, Japan, and lowland portions of Southeast Asia south to Sumatra, Java, and Borneo. In Thailand, the historical range of white ibis was the lowlands of the southeastern, central, and peninsular parts of the country (La Touche 1931-34, Medway and Wells 1976, Ali and Ripley 1968, Lekagul and Cronin 1974). Recent sightings are at Wat Tarn En , Amphur Bang Pa Han, Chagwat Ayutthaya, and at Thepparat, Changwat Chacherngsao (Virach Chantrasmi personal communication).

Geographical Status: Thailand is central in the range of the white ibis.

Habitat Requirements and Habitat Trend: White ibis inhabit river edges, marshes, flooded rice paddies, and tidal mudflats and lagoons. Nesting is colonial in shrubs or trees. The diet consists of wetland animals such as fish, frogs, molluscs, insects, and worms (Ali and Ripley 1968, Lekagul and Cronin 1974). Substantial drainage of wetland habitats has occurred.

Vulnerability of Species and Habitat: The habitat of white ibis is highly vulnerable to drainage and conversion

to agriculture. Archibald et al. (1980) consider ibis to be vulnerable to hunting and pesticide poisoning.

Causes of Threat: Unknown.

Responses to Habitat Modification: White ibis make extensive use of rice paddies.

Demographic Characteristics: The clutch contains 2-4 eggs. Incubation is estimated to take 23-25 days (Ali and Ripley 1968).

Key Behaviors: Foraging is mainly tactile, as birds walk slowly while probing the substrate. In India, the nesting season is highly variable, from June to March, depending on flooding of marshland after the monsoon begins. Both foraging and nesting are done in groups and often in association with other species of wetland birds. Social interactions are important in pair bonding, sexual development of the individual, and stimulating breeding by other colony members (Ali and Ripley 1968, Archibald et al. 1980). The species is migratory in some areas but nomadic or resident in others (La Touche 1931-34, Medway and Wells 1961, Ali and Ripley 1968).

Conservation Measures Taken: None.

Conservation Measures Proposed: A survey of the status of this species is needed, with particular attention to the existence of breeding populations and sites.

Black ibis, white-shouldered ibis

Pseudibis papillosa davisoni (Hume 1875)

Aves, Ciconiiformes, Threskiornithidae

Status: Probably extirpated.
IUCN Red Data Book (1977): Indeterminate.
IUCN (1968): Threatened.

Population Size and Trend: Precise data are lacking, but this bird was thought to be locally common in parts of southern Vietnam, northeastern Kampuchea, and Thailand in the early part of this century. It is now seriously reduced throughout its range in Southeast Asia. Except for one recent unconfirmed report from the Thale Noi wetland there have been no Thai records for over two decades. There are no estimates of the total numbers of black ibis remaining in the region (IUCN 1968, IUCN Red Data Book 1977, G. Archibald personal communication, B. King personal communication).

Distribution and History of Distribution: The overall range of P. papillosa is Pakistan, India, southwestern China, Burma, Thailand, Lao PDR, Kampuchea, southern Vietnam, Malaya, and Borneo. In Thailand there are records from Changwat Chiang Rai in the northwest, from the central valley of the Chao Phraya, and from Changwat Phuket, Krabi, Trang, and Patthalung in peninsular Thailand (Deignan 1945, Deignan 1963, Ali and Ripley 1968, King and Dickinson 1975, Medway and Wells 1976).

Geographical Status: Thailand is central in the distribution of this species.

Habitat Requirements and Habitat Trend: This ibis prefers the edges of large rivers and lakes, extensive marshes, grasslands, paddyfields, and other cultivation. The food is primarily insects, but seeds are taken (Wildash 1968). The diet of the nominate subspecies, P. p. papillosa, was given by Ali and Ripley (1968) as follows "Among the stomach contents of specimens, Mason and Lefroy (1912) identified frogs, small fish, earthworms, beetles, and other insects (including Brachytrypes achatinus adults, and larvae of Cybister confuses, Agrotis sp., and Hydrophilus sp.). In addition, lizards, small snakes, scorpions, crustaceans, and a quantity of grain have also been recorded."

Vulnerability of Species and Habitat: The large size of these birds makes them conspicuous to man. The lowland wetlands it prefers are being drained and turned into wet rice culture in much of Southeast Asia (Gibson-Hill 1949, King and Dickinson 1975, IUCN Red Data Book 1977).

Causes of Threat: Prolonged warfare throughout much of the species' range in former Indochina has probably contributed to its demise. The effects of the extensive conversion of wetlands to agriculture over the last century probably have been profound, but they are undocumented.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The demography of the subspecies davisoni is poorly known. In Burma nesting has been recorded in February and March (Smythies 1953). Ali and Ripley (1968) reported that in India the subspecies papillosa breeds from March to October in the north and later in the south. The normal clutch size was given as 2-4 eggs.

Key Behaviors: The black ibis in Thailand is shy and very difficult to approach (Deignan 1945). The subspecies papillosa nests individually, rarely in small colonies. The nest is a large stick platform 6-12 m up a large tree. Sometimes old kite and vulture nests are used. Both sexes incubate the eggs (Ali and Ripley 1968).

Conservation Measures Taken: In 1975 the Thai government designated Thale Noi as a Nonhunting Area. It is the location of the only recent reputed sighting.

Conservation Measures Proposed: The systematic status of this bird is unclear. Some authors consider davisoni to be a full species, while others consider it a subspecies of papillosa. This problem requires further study. Wetlands should be inventoried to determine what original habitat of the black ibis remains in Thailand. The staff of such wetland reserves as Thale Noi should be on the alert for this species.

Giant ibis

Pseudibis (Thaumatibis) gigantea (Oustalet 1877)

Aves, Ciconiiformes, Threskiornithidae

Status: Probably extirpated.
IUCN (1979): Threatened.
MAB (1979): Threatened.
IUCN Red Data Book (1977): Rare.
IUCN (1968): Threatened.

Population Size and Trend: This bird has always been uncommon and local and is now rare throughout its range. The total world population may be fewer than 100 birds. Although they were sighted on the Kampuchean-Lao border in 1964, there have been no records for Thailand for many decades. It is likely that this bird has been expirpated in Thailand (IUCN 1968, Fisher et al. 1969, Medway and Wells 1976, IUCN Red Data Book 1977, G. Archibald personal communication, B. King personal communication).

Distribution and History of Distribution: The giant ibis is endemic to Southeast Asia. It is known from southern Vietnam, Kampuchea, central and southern Lao PDR, central Thailand including Changwat Rat Buri and Phet Buri, and Changwat Trang and Satun in peninsular Thailand (Williamson 1916, 1921, Riley 1938, Gibson-Hill 1949, Deignan 1963, IUCN 1968, King and Dickinson 1975, Medway and Wells 1976, IUCN Red Data Book 1977).

Geographical Status: The Thai birds lived at the western and southern extremes of the species' known range.

Habitat Requirements and Habitat Trend: Primarily an inhabitant of the lowlands, this large ibis prefers lakes, swamps, marshes, wooded plains, open forest, and clearings and ponds in deep forest (Deignan 1963, Lekagul and Cronin 1974, King and Dickinson 1975, IUCN Red Data Book 1977).

Vulnerability of Species and Habitat: The large size of this bird makes it very conspicuous to man. In times of drought they are said to aggregate at permanent water holes. Moist lowland habitat in all of Southeast Asia is being drained and converted into wet rice culture.

Causes of Threat: The hostilities over most of its range have undoubtedly taken their toll of these magnificent birds. Overhunting and loss of wetland habitat threaten the remaining populations.

Responses to Habitat Modification: The virtually complete conversion of the central valley of the Chao Phraya to agriculture was probably instrumental in the extirpation of *P. gigantea* from Thailand.

Demographic Characteristics: The populations in peninsular Thailand were apparently migrants or strays; there were no breeding records outside of central Thailand, Kampuchea, the Lao PDR, and southern Vietnam (Fisher et al. 1969). The clutch size and other demographic characteristics are unknown. Most ibises have 2-5 eggs per clutch (Archibald et al. 1980).

Key Behaviors: Very little is known of the habits of this bird. It is said to be very shy and wary and to venture forth in pairs and small groups (Wildash 1968, IUCN Red Data Book 1977).

Conservation Measures Taken: The giant ibis was once taken (Gibson-Hill 1949) in what is now Tarutao Marine National Park. IUCN Red Data Book (1977) stated that this ibis is protected from hunting or capture by Thai law.

Conservation Measures Proposed: Whenever it becomes possible an intensive survey of the area north of Tonle Sap in Kampuchea should be conducted to determine the current status of this species. Any surviving populations found should be studied to determine the best methods for conserving them. In view of the fact that this bird once ranged far beyond its breeding range into suitable habitat in south Thailand, biologists working at Thale Noi and other wetlands should watch for this species.

White-winged wood duck

Cairina scutulata (S. Muller)

Aves, Anseriformes, Anatidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN Red Data Book (1977): Vulnerable.
IUCN (1979): Threatened.
MAB (1979): Threatened.
WARPA (1972): Rare.

Population Size and Trend: Originally this species was fairly common in peninsular Thailand (Glenister 1955), but now only one population is thought to remain in the country (Lekagul and Cronin 1974, IUCN Red Data Book 1977, IUCN 1979). Modest numbers are reported from the Sweli River (Smythies 1953), the Pablakhali area of the Chittagong Hills (Husain 1977), and several other areas of Burma (Yin 1977), and in Lampung, Palembang, and Jambi provinces, Sumatra (Holmes 1977). The 1971 population of 1000 ducks at the Moe-Yun-Gyi Waterfowl Sanctuary, Burma, has declined to 100 (Kear and Williams 1978).

Distribution and History of Distribution: The white-winged wood duck occurred discontinuously from India, Assam, Bangladesh, and Burma east to central and southern Lao PDR, Kampuchea, and Vietnam, and from northern Thailand south to Malaya, Sumatra, Siberut, and Java (Delacour 1959, Dickinson 1970, IUCN Red Data Book 1977). The species apparently has been extirpated from Malaya and Indochina, but isolated population are still reported in Assam, Bangladesh, Burma, Thailand, Java, Sumatra, and Siberut (IUCN Red Data Book 1977, Kear and Williams 1978).

Geographical Status: Thailand is central in the species' range.

Habitat Requirements and Habitat Trend: The species lives in primary evergreen forest, from lowland swamps and plains forest to forested intermontaine basins as high as 1500 m (Deignan 1945, Husain 1977, IUCN Red Data Book 1977, Holmes 1977). Evidently low population densities are normal (Deignan 1945); a maximum of 1 pair per 100 ha of ideal habitat is estimated (MacKenzie and Kear 1976, Holmes 1977). The trees are used for roosting, and nesting is in the tree hollows and on large branches. Foraging habitat is slow-moving streams and rivers, marshes, and sheltered wet depressions in the forest; foraging also may occur on

the forest floor and nearby flooded rice fields. MacKenzie and Kear (1976) suggested that during the monsoon season all foraging may take place within the forest but during the dry season daily flights outside of the forest may be necessary. Hence populations need both primary forest with slow-moving waters and dry-season wetlands within a few km of the forest roost. In captivity the species is omnivorous, prefers animal food, and chases small fish (Ali and Ripley 1968). Discrepancies among various reports suggest seasonal changes in diet (MacKenzie and Kear 1976).

Vulnerability of Species and Habitat: Habitat of the white-winged wood duck is vulnerable to deforestation, which also increases the accessibility of the species to hunting.

Causes of Threat: From an original 80 percent, forest cover of Thailand has declined to 53 percent in 1961, 39 percent in 1973, and 25 percent in 1978 (Myers 1980). Relictual areas of suitable habitat remain, but evidently all the wood ducks in them have been killed.

Responses to Habitat Modification: The species cannot survive loss of its forest habitat. Replacement of native forest with plantations of fast-growing species is an unsuitable substitution (MacKenzie and Kear 1976). The ducks can continue to occupy partially disturbed forest in which remnant patches of primary forest or dense, old, secondary forest are allowed to remain (Holmes 1977).

Demographic Characteristics: Clutch size ranges from 6-13 eggs, usually 10. A second clutch may be laid if the first is removed. The incubation period is 33-35 days. Females become sexually mature in 2-3 years.

Key Behaviors: Nesting is monsoonal in Assam, beginning in May with molting occurring in September (MacKenzie and Kear 1976). However, breeding in Sumatra and Java has been reported in December and February, respectively (Hoogerwerf 1950) and was surmized to span the Sumatran wet season from December to March or April by Holmes (1977). According to most authors (see Holmes 1977), when birds must commute to foraging areas, they do so just before dusk, remain on the feeding ground all night, and return to the roost in the morning.

Conservation Measures Taken: White-winged wood ducks are protected by the Wild Animals Reservation and Protection Act of 1972, though export of the birds cannot any longer be a significant cause of threat.

Conservation Measures Proposed: The report that the species occurs in Huai Kha Khaeng Wildlife Sanctuary (IUCN 1979) should be verified; if it is true, the population should be protected and managed as a top priority. It may be feasible to reestablish the white-winged wood duck in Thailand with a captive breeding program and reintroduction into the wild. Suitable habitat should be selected carefully, and a visit to become familiar with the habitat of the wood duck population in the Kassalong Reserve, Chittagong Hills, Bangladesh, the Way Kambas Wildlife Reserve, Sumatra, or the Reserve Forests of Assam would be useful in planning. Suitable habitat is reported to occur at Thung Thong Wildlife Sanctuary (IUCN 1979). MacKenzie and Kear (1976) recommend providing both wet and dry season feeding habitats within 4 km (Holmes 1977) of each other. Once chosen, the reintroduction area would need complete protection from logging and hunting. Captive breeding techniques have been developed by the Wildfowl Trust, Slimbridge, England. "By 1976, about 70 birds were held in captive wildfowl collections in Europe, North America, and Asia. All birds outside Asia are related to the Wildfowl Trust stock" (IUCN Red Data Book 1977), which came from Assam (Johnstone 1972). By 1978, over 100 wood ducks had been reared at Slimbridge, but the stock was becoming inbred (Kear and Williams 1978). MacKenzie and Kear (1976) listed field research needs for sound conservation planning.

Pet hong, comb duck

Sarkidiornis melanotos (Pennant 1769)

Aves, Anseriformes, Anatidae

Status: Threatened.
CITES (1979): Appendix II.
WARPA (1972): Rare.

Population Size and Trend: There are no estimates of the total numbers of this widespread duck. There are numerous reports of it having once been locally common in Southeast Asia. Smythies (1953) noted almost three decades ago that it was becoming scarce in Burma due to overhunting. Lekagul and Cronin (1974) considered it to be an uncommon resident in Thailand.

Distribution and History of Distribution: This tropical duck is known from Panama south to Peru and Argentina in the New World, throughout Africa south of the Sahara (including Madagascar), and in Asia from Pakistan, India, and Bangladesh east through Burma and southeastern China to Thailand, Kampuchea, central Lao PDR, and southern Vietnam. Its occurrence is patchy throughout its range and some populations (e.g. in Sri Lanka) are thought to have become extinct. In Thailand it is known from the northwest, the northeast, and the central valley of the Chao Phraya (Deignan 1945, Smythies 1953, Delacour 1959, Deignan 1963, Ali and Ripley 1968, Henry 1971, Lekagul and Cronin 1974, McClure 1974b, King and Dickinson 1975, Kear and Williams, 1978).

Geographical Status: In Southeast Asia these birds are at the eastern extreme of the species' extensive range.

Habitat Requirements and Habitat Trend: In Thailand this tree duck prefers woodland ponds and streams in the dry season and marshes and flooded fields in the rainy season (Lekagul and Cronin 1974). It has been reported from a wide variety of habitats, from wet places in savannas to deep forest. It is thought to be primarily an herbivore, subsisting on the corms, shoots, and seeds of aquatic and marsh plants. Wild and domestic rice is also eaten, as are the aquatic larvae of insects, fish, and frogs (Delacour 1959, Ali and Ripley 1968, Wildash 1968, Henry 1971).

Vulnerability of Species and Habitat: This is the largest of the Thai ducks. Although its large size, relatively diurnal activity patterns, and habitat of consuming rice would tend to bring it to the attention of hunters, it is usually silent and its flesh is reputed to be tough and coarse. It resembles domestic Muscovies and is taken alive for the trade (Deignan 1945, Henry 1971).

Causes of Threat: Overhunting threatens this species. In addition to being killed as food, S. melanotos is captured alive in many parts of its range, including Thailand. Twelve were exported from Thailand in 1962, for example (Royal Forestry Department 1972, Kear and Williams 1978).

Responses to Habitat Modification: This species readily adapts to the conversion of wetlands to rice culture, but may be excluded from an area by the lack of suitable nesting sites.

Demographic Characteristics: The breeding season varies over the species' range. Comb ducks have been reported to nest July-September in India and June-September in Burma. The usual clutch is 7-15 eggs. Incubation lasts a month. The average survival time of the birds banded by McClure (1974) was 11 months. The oldest recovery was 50 months (Smythies 1953, Delacour 1959, Ali and Ripley 1968, Henry 1971, McClure 1974b).

Key Behaviors: Comb ducks are less nocturnal than most ducks. It night-roosts in trees but walks well on the ground and often feeds there. It is a grazing duck. It will not normally dive to feed but readily dives to escape danger. Small parties of 4-10 or flocks of 25-30 are seen. Rarely groups of a hundred or more occur. The flocks fly in a loose mob and do not form the orderly V's characteristic of many waterfowl. The flight is strong and can be sustained for great distances. Band recoveries in Asian comb ducks averaged 320 km and movements as far as 960 km were recorded (McClure 1974b). The migratory habits of the Thai populations are unknown. These birds commonly make local migrations in search of water and breeding sites. The preferred nesting site is a large natural cavity in a large tree near water. Nests far removed from open water have been noted. When no suitable trees are available, comb ducks may nest in old vulture nests, earthen and rock cliffs, in ruins, or reeds. When nesting sites are scarce comb ducks may share a cavity with another of their kind (up to 47 eggs have been taken from one nest) or other species of ducks. The mating behavior has been described by Delacour (1959). The female alone incubates the eggs and cares for the young (Smythies 1953, Delacour 1959, Ali and Ripley 1968, Henry 1971, Lekagul and McNeely 1974, McClure 1974b, King and Dickinson 1975).

Conservation Measures Taken: Thai law (WARPA 1972) protects this species. It will breed and live long in captivity. As late as 1937 Deignan (1945) saw captives in Chiang Mai descended from a group Gyldenstolpe (1916) had seen several decades earlier. Captives appeared in the West as early as 1876 at London Zoo. The Wildfowl Trust now has a breeding population of about a dozen at Slimbridge. This bird will hybridize with the South American subspecies in captivity and should therefore be kept apart from it to maintain the genetic integrity of the captive stock (Delacour 1959, Lubbock 1979).

Conservation Measures Proposed: Sportsmen and conservation officials (especially those working at wetlands) should be trained to recognize this species and preserve it and its nesting trees. Cooperative banding studies with other Southeast Asian nations would help in elucidating the movements and life history of the Thai comb ducks. As a relative of our domestic fowl, it represents a valuable genetic resource and should be preserved.

Peregrine falcon, duck hawk

Falco peregrinus Tunstall 1771

Aves, Falconiformes, Falconidae

Status: Endangered.
CITES (1979): Appendix I.

Population Size and Trend: Population size and trend in Asia are unknown (IUCN Red Data Book 1979). The species is rare to common (La Touche 1931-34, Smythies 1953, Deignan 1945, Cheng 1963, Lekagul and Cronin 1974) in the region.

Distribution and History of Distribution: The peregrine is widespread in open lowlands and along coasts in all of Thailand except the Khorat Plateau (Deignan 1945, Madoc 1961, McClure and Lekagul 1961, Dickinson 1966, Ogle 1974, Lekagul and Cronin 1974, Holmes and Wells 1975, Medway and Wells 1976).

Geographical Status: All records of this species in Thailand appear to be migrants and winter residents, occurring from July to February. These records have been assigned variously to subspecies japonensis, calidus, and peregrinator, but they are most likely to be P. p. peregrinator, which breeds in India, Bangladesh, Burma, and southern and eastern China. The hiatus between breeding populations of Chinese peregrinator and Malaysian nesiotes is peculiar. That peregrines do not breed in the humid tropical forest regions of the world (Brown and Amadon 1968) is disproved by the Malaysia-Indonesia breeding range of nesiotes.

Habitat Requirements and Habitat Trend: The peregrine frequents lowlands, river valleys, and coasts, particularly around marshes where waterfowl are abundant. It also occurs in large cities, where it roosts on tall buildings and eats mainly pigeons. Nesting is usually on a cliff ledge, sometimes on a tall building or in a tree. The diet is mostly birds, particularly ducks, gulls, shorebirds, pigeons, thrushes, and finches (Cheng 1963). In Burma, the favored foods are pigeons, parrots, bats, and ducks (Smythies 1953). The food requirement is about 11-12 percent of body weight, with 80-100 g of food consumed daily.

Vulnerability of Species and Habitat: As a top carnivore, the species ingests chlorinated hydrocarbon insecticides (such as DDT and its

metabolite, DDE) that have been concentrated through the food chain in the tissues of its prey, causing reduced thickness of the egg shell, which breaks during incubation (see for example Hickey 1969, Peakall and Kiff 1979). Hence reproduction fails. Though these pesticides are not a problem in low-intensity agricultural land or native vegetation, they can be acquired in winter or breeding range, so a very large region without high-intensity agriculture is needed to maintain healthy populations. Reduction of waterfowl populations by excessive hunting can be a problem and drainage of marshes causes loss of optimal foraging habitat.

Causes of Threat: High-intensity agriculture is rapidly being adopted in Southeast Asia and is posing an increasing threat to reproduction of migratory peregrines from China. Much marsh habitat in Thailand has been drained and converted to agricultural use.

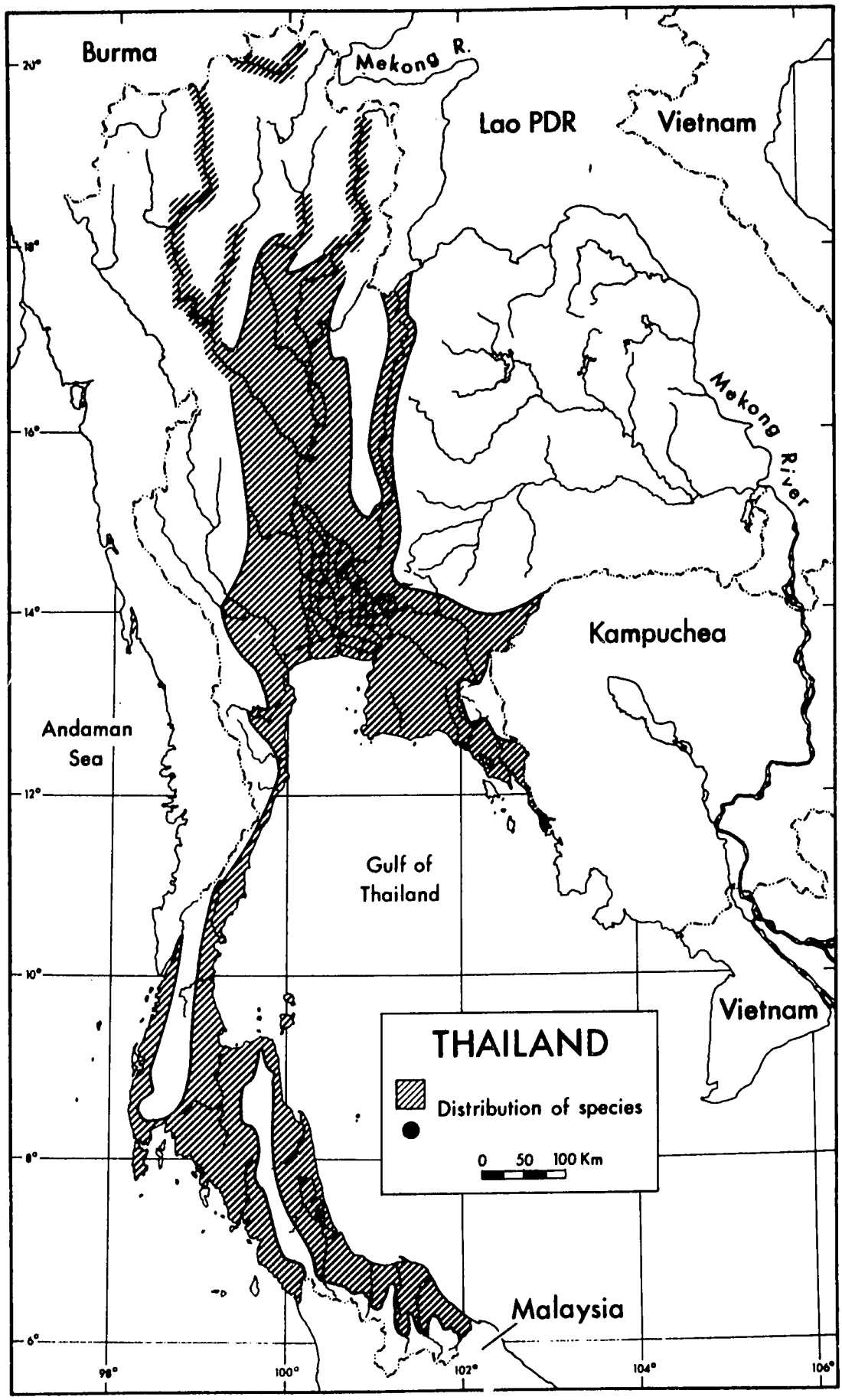
Responses to Habitat Modification: The peregrine is tolerant of a wide array of habitat changes (IUCN Red Data Book 1979).

Demographic Characteristics: A normal clutch includes 3-4 eggs, with a range of 2-6. Incubation takes 28-29 days. The female tends the nestlings closely for their first 2 weeks of life, while they are provisioned by the male; thereafter she spends much time away from the nest (Brown and Amadon 1968). Young remain in the nest for 35-40 days (Cheng 1963). After the young are fledged, they may remain dependent on their parents for 2 months or more prior to migration. Peregrines live up to 12 years in the wild, but 2-3 years after reaching sexual maturity is the average longevity (Brown and Amadon 1968). Sharply declining populations in North America exhibit annual mortality rates of 70-74 percent in immatures and 25 percent in adults (Enderson 1969).

Key Behaviors: Peregrines mate for life, remating only when one of the pair dies. A suitable nesting site is very important to peregrines, and a suitable cliff may be occupied over many successive generations. Migration usually occurs along river valleys and coasts (Brown and Amadon 1968).

Conservation Measures Taken: None in Thailand.

Conservation Measures Proposed: International control of chlorinated hydrocarbon poisons will be necessary to conserve this long-distance migrant. Presumably at risk from any such environmental contamination in Thailand is a large portion of China's breeding population of peregrines. A positive step would be to inventory peregrines wintering at marshes in Thailand for the purpose of devising a conservation plan for these important habitats.



Falco peregrinus

Roulroul, crested green wood-partridge

Rollulus roulroul (Scopoli 1786)

Aves, Galliformes, Phasianidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: The total numbers of roulrouls in Thailand are unknown. It is considered to be an uncommon resident (Lekagul and Cronin 1974).

Distribution and History of Distribution: This animal is known from "peninsular Burma and from 13° N in peninsular Thailand to Sumatra, Banka, Belitung, and Borneo" (Medway and Wells 1976).

Geographical Status: The Thai population is peripheral, lying at the northern limits of the species' distribution.

Habitat Requirements and Habitat Trend: Roulrouls are known from sea level to about 1220 m. They inhabit dense undergrowth in drier primary and mature secondary forest and sometimes bamboo. They are said to subsist on berries and insects (Delacour 1947, Glenister 1955, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976).

Vulnerability of Species and Habitat: The colorful plumage of this bird, including the male's conspicuous red crest, makes it especially attractive to humans. Although quite shy and rarely seen it is easily trapped (Riley 1938, Glenister 1955). The mature forests it requires are being cleared at an unprecedented rate.

Causes of Threat: Forest clearing and hunting threaten this species. Annual exports from Thailand from 1967 to 1971 were 94, 99, 104, 86, and 192 (Royal Forestry Department 1972).

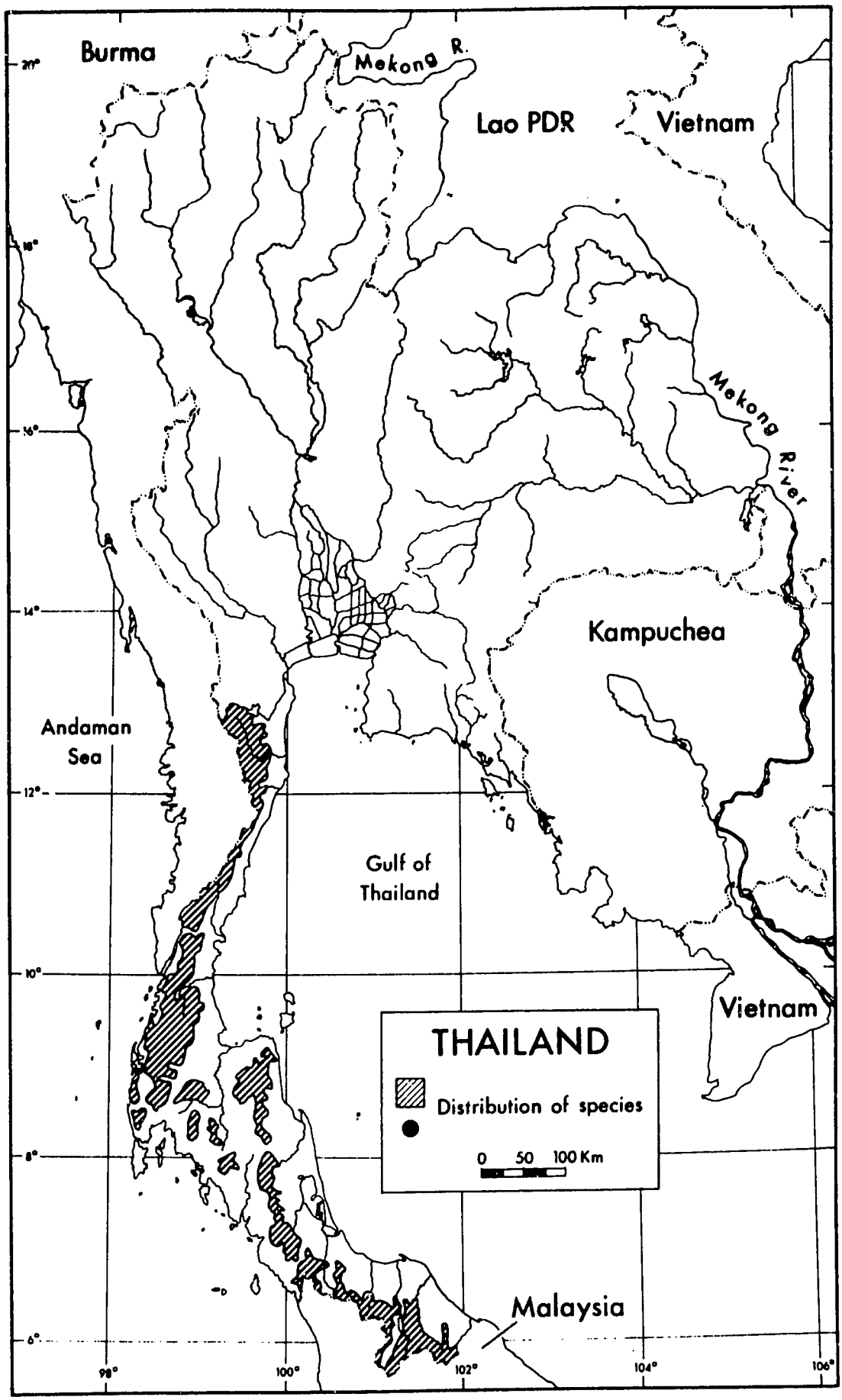
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Nests with eggs have been found during many parts of the year in Malaysia. Perhaps these birds breed throughout the year in Thailand. The usual clutch size is 5-6 eggs (Medway and Wells 1976).

Key Behaviors: The vocalization, a low whistle, is given most persistently at daybreak. They are seen singly, in pairs, and in small coveys (Delacour 1947, Glenister 1955, Holmes 1973, Medway and Wells 1976).

Conservation Measures Taken: Roulrouls are protected under the Wild Animals Reservation and Protection Act of 1972, which prohibits hunting and allows export only with special permission from the Wildlife Advisory Committee of the Wildlife Conservation Division. They are said to occur in Ton Nga Chang Wildlife Sanctuary (IUCN 1979).

Conservation Measures Proposed: Field studies on the remaining roul-rouls in south Thailand would be most timely. Management of forest reserves should include provisions for the maintenance of dense undergrowth, which these animals require for cover. Methods for captive rearing have been demonstrated (Glenister 1955), and the species is bred commonly by private citizens in Thailand (Virach Chantrasmi personal communication).



Rollulus roulroul

Kalij pheasant

Lophura leucomelana (Latham)

Aves, Galliformes, Phasianidae

Status: Threatened.
IUCN (1979): Threatened.
WARPA (1972): Rare.

Population Size and Trend: Unknown. Populations in suitable habitat can be common (Delacour 1951). In Burma the species was considered fairly common but becoming scarce in accessible areas because of hunting (Smythies 1953). Kalij pheasants were considered uncommon in Thailand (Lekagul and Cronin 1974).

Distribution and History of Distribution: Kalij pheasants occur in the foothills and mountains (100+ m) of western Thailand, west of the Mae Nam Ping and central plains, between latitudes 12° and 19°. They do not remain where large expanses of forest are completely converted to a agriculture (Delacour 1949, 1951). The reports of this species in Khao Yai National Park (McClure 1974) and Phu Luang Wildlife Sancturary (IUCN 1979) are surely erroneous. Elsewhere the species occurs in Burma, Bhutan, southwestern China, Nepal, and northern India.

Geographical Status: Thailand is the southeastern limit of the range of Kalij pheasants.

Habitat Requirements and Habitat Trend: This is a bird of the teak-bamboo forest, especially where undergrowth is thick, in rocky ravines, and near streams. It often occurs in association with junglefowl but prefers moister microhabitats than the latter species. Kalij pheasants move out onto roads, clearings, or edges of cultivated fields on moonlit nights and early in the morning. Nests are shallow scrapes on the ground. The diet consists of grain, seeds, young leaves and grass, insects and their larvae, and small reptiles (Delacour 1951, Smythies 1953, Ali and Ripley 1969).

Vulnerability of Species and Habitat: The species is vulnerable to hunting--particularly the males, which readily come to decoys. However, the birds are difficult to see in the thick cover they prefer, and they run when disturbed (Smythies 1953). The habitat is vulnerable to deforestation.

Causes of Threat: Hunting is a cause of threat (Smythies 1953), and much habitat has been deforested.

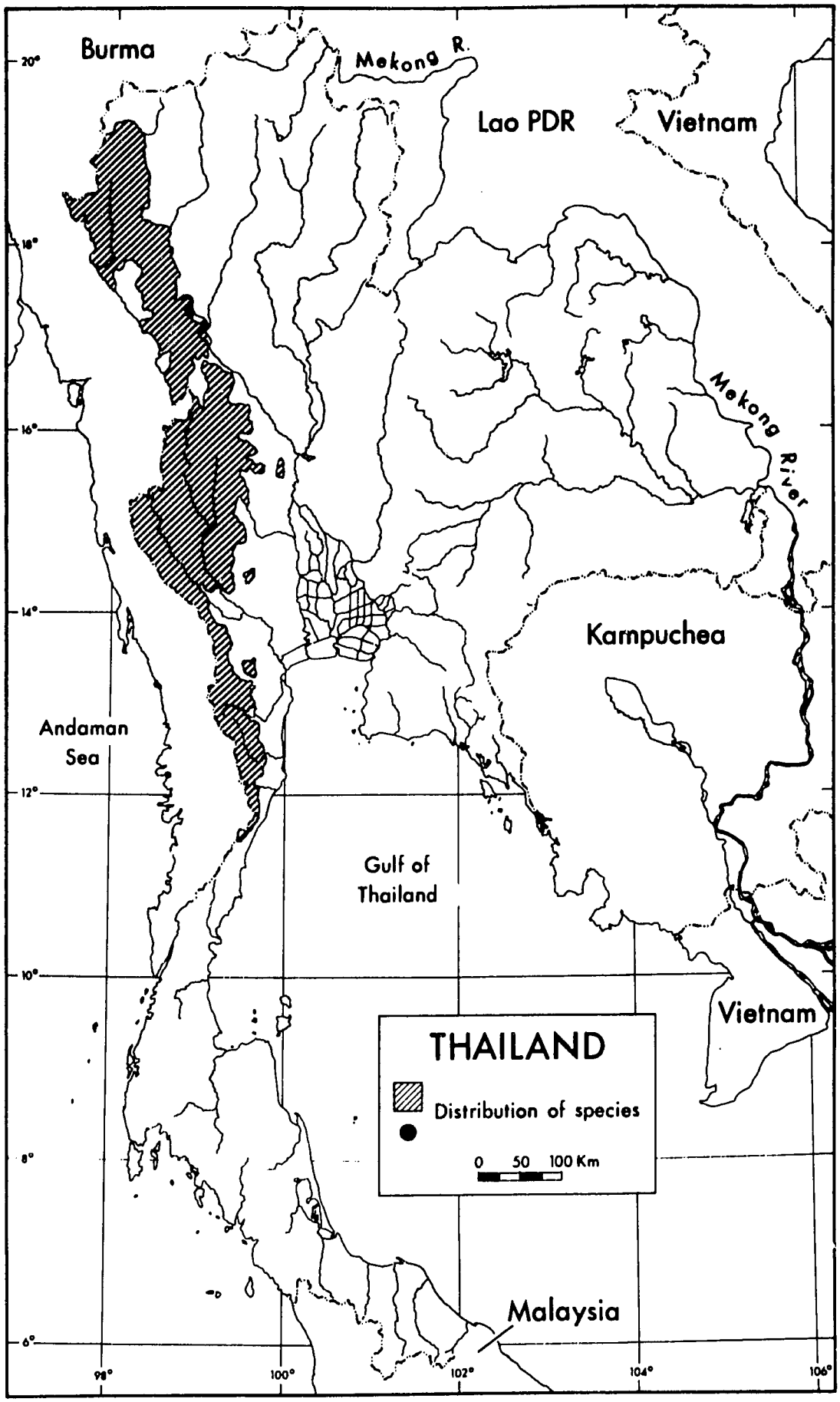
Responses to Habitat Modification: Kalij pheasants use small areas of cultivation that are included in their activity ranges, but they cannot live where their forest habitat is removed.

Demographic Characteristics: The clutch contains 4-10 eggs. Incubation by the hen takes 25 days. Most birds breed from March to May, but in the south nesting may start as early as January. Second nests can occur until October (Smythies 1953, Delacour 1951). Birds are sexually mature when 1 year old (Delacour 1949).

Key Behaviors: Males display by making a drumming sound, from rapid wingbeats against the body.

Conservation Measures Taken: Hunting and export of the species are controlled by Thai law (WARPA 1972). Kalij pheasants live in Huai Kha Khaeng Wildlife Sanctuary (McNeely and Seidensticker 1974) and probably in other parks or reserves in western Thailand. Many of these birds are in zoos and pheasantries around the world.

Conservation Measures Proposed: Parks, sanctuaries, and other forested tracts in western Thailand should be surveyed for this species. Research is needed to determine if legal control of harvest is adequate to maintain populations. If this species were shown to be polygamous, it may be possible to design a management strategy to harvest surplus males.



Lophura leucomelana

Silver pheasant

Lophura nycthemera (Linnaeus)

Aves, Galliformes, Phasianidae

Status: Threatened.
IUCN (1979): Threatened.
WARPA (1972): Rare.

Population Size and Trend: The silver pheasant is common in montane forest where hunting has not been excessive, though its range is by nature fragmentary.

Distribution and History of Distribution: This species occurs across southern China, on Hainan, in Vietnam, Lao PDR, western Kampuchea, Thailand, and Burma. In Thailand the species occurs discontinously in mountain forest above 800 m in the north, the Petchabun Range, and the southeast (Delacour 1949, 1951). Deforestation has increased the fragmentation of this range.

Geographical Status: Thailand is the southwestern limit of the range of silver pheasants.

Habitat Requirements and Habitat Trend: The silver pheasant lives in montane or premontane forest with dense undergrowth, from elevations of 800-2750 m. Hence it occupies a variety of vegetation types, including mixed deciduous, pine, and hill evergreen forests. Foraging includes small clearings and roadways (Deignan 1945, Smythies 1953).

Vulnerability of Species and Habitat: The species is vulnerable to hunting. La Touche (1931-34) described how people in China shot from blinds at birds baited with grain, as well as at night roosts by torchlight. The habitat is vulnerable to deforestation.

Causes of Threat: Habitat loss threatens this species in Thailand.

Responses to Habitat Modification: Unknown.

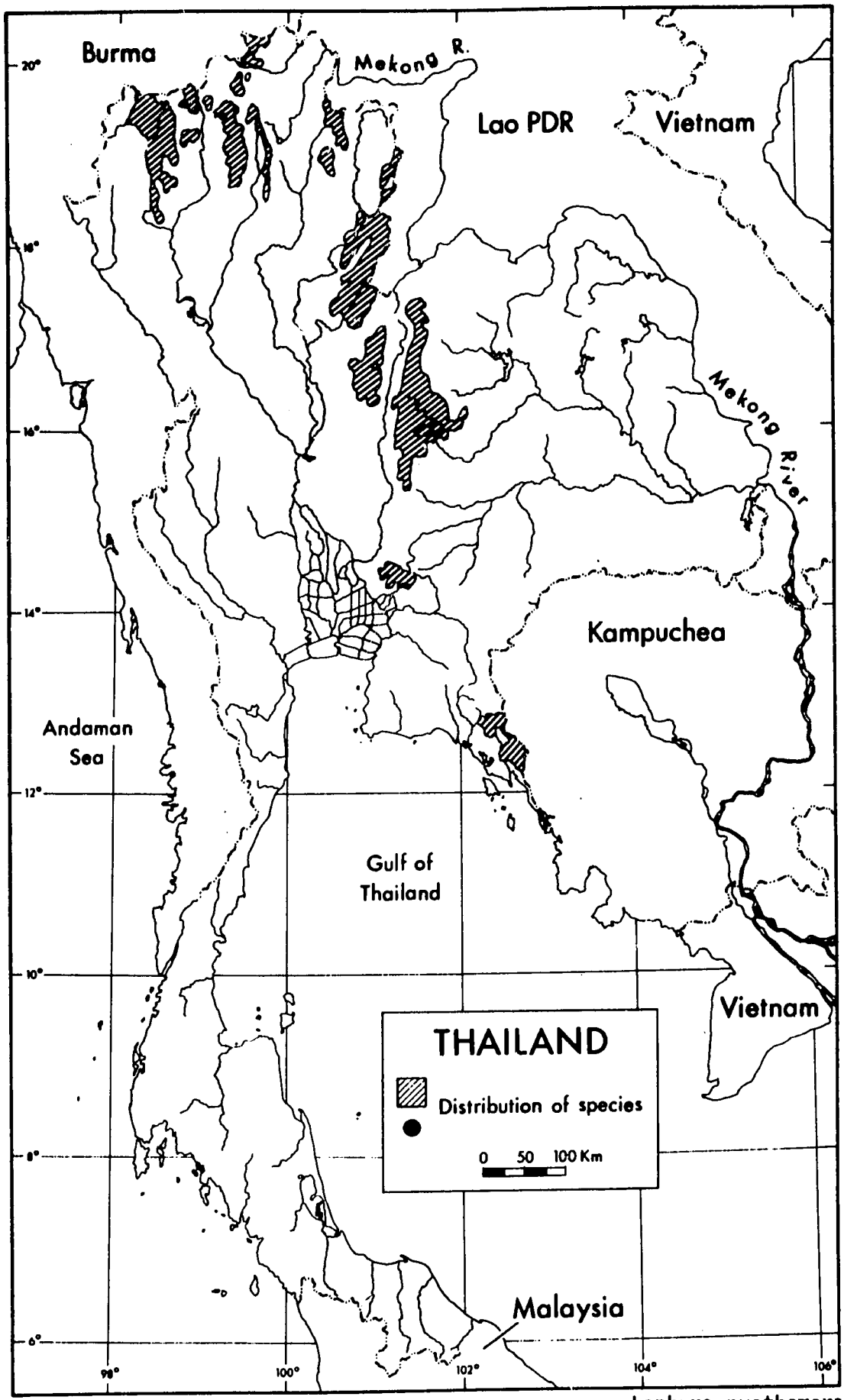
Demographic Characteristics: The clutch contains 2-4 eggs, and incubation takes 23 days (Delacour 1951). Birds are not sexually

mature until 2 years old (Delacour 1949). The maxumum life span of tame silver pheasants is 21 years (Cheng 1963).

Key Behaviors: Though usually monogamous in captivity, free-ranging silver pheasants are polygamous. Consequently, social groups in the breeding season typically consist of 1 male and several females (Delacour 1949).

Conservation Measures Taken: Hunting and export of silver pheasants are regulated in Thailand (WARPA 1972). The species occurs in several national parks (NP) and wildlife sanctuaries (WS): Khao Yai NP (Dickinson 1964), Phu Luang WS (IUCN 1979), and Doi Inthanon NP, Doi Khuntan NP, and Doi Chiang Dao WS (Deignan 1945). Many silver pheasants are in zoos and pheasantries around the world.

Conservation Measures Proposed: More detailed information is needed on the distribution of silver pheasants in Thailand, and the threat of deforestation needs better documentation. It may be possible to design a management plan of harvesting surplus males in this polygamous species, and research on population dynamics is needed to determine densities, the number of surplus birds, and the rate at which they are replaced. However, caution is appropriate, because the relatively long period this species takes to reach sexual maturity suggests that the reproductive ability to replace harvested individuals is limited.



Lophura nycthemera

Creasted fireback pheasant

Lophura ignita (Shaw and Nodder 1797)

Aves, Galliformes, Phasianidae

Status: Threatened.
IUCN (1979): Threatened.
WARPA (1972): Rare.

Population Size and Trend: Unknown. Beebe (1926) found creasted firebacks to be relatively common in peninsular Malaysia and Borneo but very patchy in local occurrence;similarly they are "sparingly distributed" in southern Burma (Smythies 1953). Glenister (1955) considered them rare, and Lekagul and Cronin (1974) termed them uncommon.

Distribution and History of Distribution: Creasted firebacks occur in the Mergui district of Burma, Thailand south of the Isthmus of Kra including Ko Phuket, peninsular Malaysia, Sumatra, Bangka, and Borneo (Delacour 1949, Medway and Wells 1976). Actual distribution within this range is restricted to forest below 600-1200 m. This range has been greatly reduced and fragmented by habitat loss.

Geographical Status: Thailand is the northern limit of this species' range.

Habitat Requirements and Habitat Trend: The creasted fireback occupies lowland tropical forest up to 600-1200 m elevation (Delacour 1949). Beebe (1926) found flocks frequenting successional vine tangles on sites of previous swidden agriculture, and the birds foraged in the nearby primary forest. Such patches of dense cover also develop in light gaps made by fallen trees. The diet consists of seeds, leaves, berries, and small insects (Beebe 1926, Smythies 1953). Very little lowland forest remains in southern Thailand.

Vulnerability of Species and Habitat: The species is vulnerable to trapping. Its habitat is highly vulnerable to deforestation.

Causes of Threat: Habitat loss is a major threat to this species.

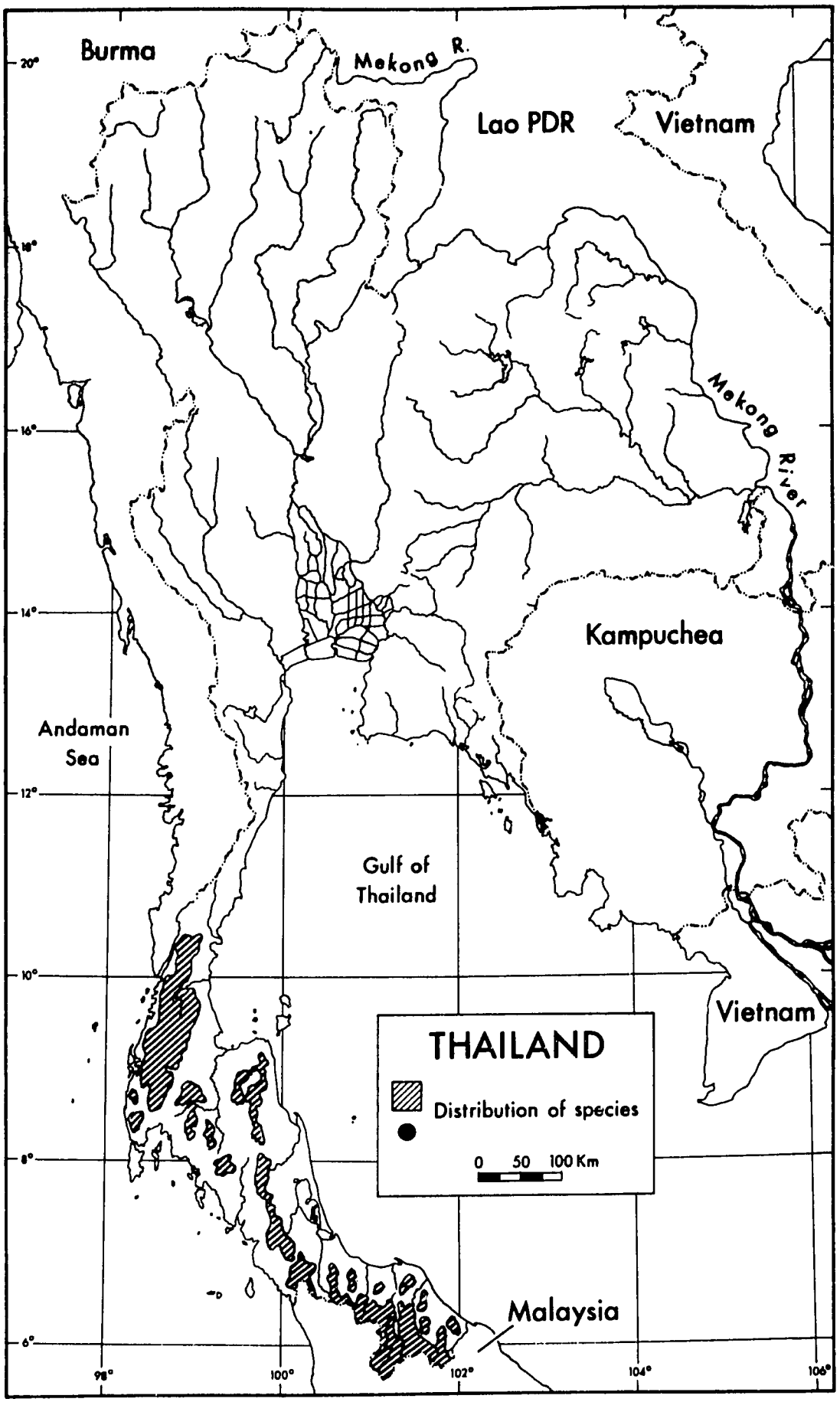
Responses to Habitat Modification: Creasted firebacks never venture into forest clearings (Smythies 1953).

Demographic Characteristics: Birds are sexually mature when 2 years old. A clutch contains 5-8 eggs. Incubation takes 24-25 days (Delacour 1951).

Key Behaviors: Free-ranging birds occur in flocks containing 1 male and several females, indicating a polygamous mating system (Beebe 1926, Smythies 1953). Flocks can be found by stalking the location of calls or the whirring sound made with their wings (Smythies 1953).

Conservation Measures Taken: None. Many creasted firebacks are in zoos and pheasantries around the world.

Conservation Measures Proposed: Basic information on current status and distribution is needed. Loss of lowland forests in southern Thailand has reached an extreme that a search for surviving populations should focus on existing or proposed national parks, wildlife sanctuaries, and nonhunting areas.



Lophura ignita

Siamese fireback pheasant

Lophura diardi (Bonaparte 1856)

Aves, Galliformes, Phasianidae

Status: Threatened.
IUCN (1979): Threatened.
WARPA (1972): Rare.

Population Size and Trend: The Siamese fireback was common to abundant in suitable habitat (Delacour 1951) but now is considered uncommon (Lekagul and Cronin 1974). Evidently the species typically was rare in northern Thailand (Deignan 1945).

Distribution and History of Distribution: This species occurs in Vietnam, southern Lao PDR, northern Kampuchea, and eastern and north-central Thailand. Early reports of firebacks in eastern Burma have not been substantiated. In Thailand the species does not occur west of the Mae Nam Yom or the Khuntan Mountains (Delacour 1951). This distribution has become much reduced and fragmented by habitat conversion.

Geographical Status: Thailand provides the western half of the range of the species.

Habitat Requirements and Habitat Trend: The Siamese fireback occurs in lowlands up to 600 m, including forest, bamboo thickets, and abandoned, overgrown agricultural land (Deignan 1945, Delacour 1951). Because lowland forests are the first to be cleared, habitat loss has been great.

Vulnerability of Species and Habitat: The species is difficult to shoot in its dense cover, but it is very easy to trap. This fireback has been trapped for export for many decades (Beebe 1926). Very little lowland forest remains in Thailand, but early successional cover may support populations.

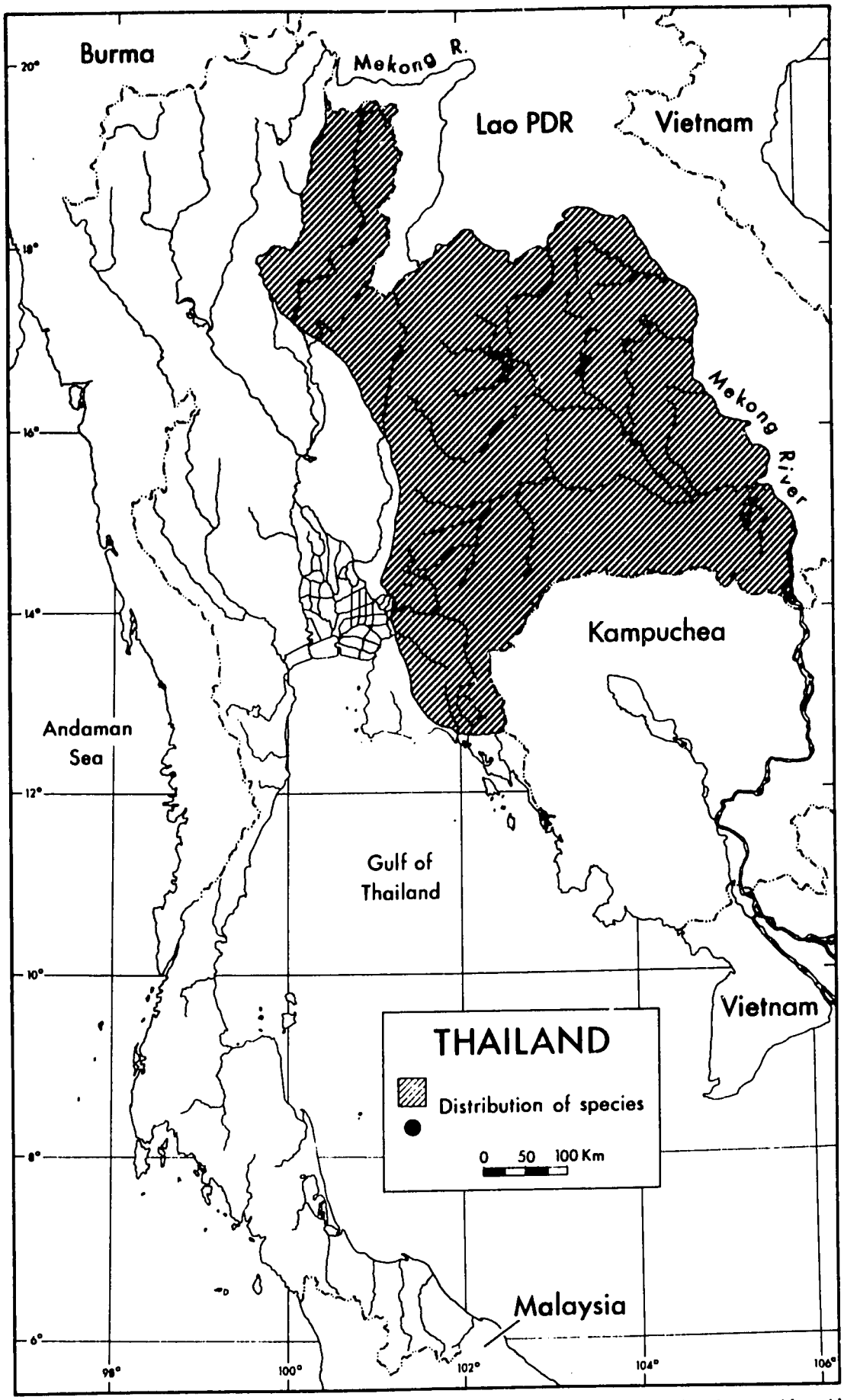
Causes of Threat: Deforestation and trapping threatens this species.

Responses to Habitat Modification: The species uses roads, clearings, and successional habitats (Deignan 1945, Delacour 1951).

Demographic Characteristics: Eggs are 5-8 to a clutch. Incubation takes 24-25 days. Females usually are not sexually mature until 3 years of age (Delacour 1951).

Conservation Measures Taken: Thailand regulates hunting and export of Siamese firebacks (WARPA 1972). The species is reported to occur in several national parks (NP) and wildlife sanctuaries (WS): Thung Salang Luang NP (Dickinson and Chaiyaphun 1970), Nam Nao NP, Khao Sabap NP, Sam Larn (proposed) NP, Phu Luang WS, and Phu Miang-Phu Thong WS (IUCN 1979). Many Siamese firebacks are in zoos and pheasantries around the world.

Conservation Measures Proposed: A detailed distributional survey is needed. Studies of the dynamics of populations protected in parks and sanctuaries would show whether existing regulations provide adequate protection for populations not in reserve areas.



Lophura diardi

Mrs. Hume's pheasant, barred-back pheasant

Syrmaticus humiae (Hume 1881)

Aves, Galliformes, Phasianidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN (1979): Threatened.
IUCN Red Data Book (1977): Rare.

Population Size and Trend: Unknown. Populations are discontinuous on mountains and range from locally rare to locally abundant, and no clear view of population status emerges from existing information. Some populations may have declined because of overhunting. All authors have considered this pheasant rare in Thailand (Deignan 1945, Smythies 1953, Ali and Ripley 1969, Lekagul and Cronin 1974, IUCN Red Data Book 1977).

Distribution and History of Distribution: Hume's pheasant "occurs from the hills of northern Burma west of the Irrawaddy River to Manipur, Naga, Patkai and the Lushai Hills of Assam, India, south through Burma's Chin Hills to Mt. Victoria, and north to the mountains of the border between Burma, and India and China including Tibet"...and east of the Irawaddy River in Burma, in the Shan highlands and into south-western Yunnan across the Salween River, south to northwestern Thailand" (IUCN Red Data Book 1977). In Thailand it is reported only from Doi Lang Ka, Doi Suthep, and Doi Chiang Dao, with the last published sighting in 1933 (Deignan 1945, Young). In 1935-37, Deignan failed to find Hume's pheasants on Doi Suthep despite considerable effort. No change in distribution of the species is documented, but these reports suggest the possibility that it is extirpated from Thailand. On the other hand, it is possible that a thorough survey of potential habitat would reveal other populations in northwestern Thailand.

Geographical Status: The Thailand populations are disjunct and on the periphery of the species' range.

Habitat Requirements and Habitat Trend: The habitat of Hume's pheasant is oak, oak-chestnut, and pine forests with interspersed patches of bracken fern and lalang (Imperata grassland) on hills and mountains from 900-3355 m elevation. Nests are built on the ground. The trees are used for escape cover (Deignan 1945, Smythies 1953, Ali and Ripley 1969). Because this habitat mosaic is maintained naturally by local fires, Hume's pheasant should be considered a fire disclimax species.

Vulnerability of Species and Habitat: Hunting and trapping have the potential of extirpating localized populations (IUCN Red Data Book 1977). As human population densities increase, large-scale, permanent conversion of montane land to agriculture and lalang grassland will cause increasing habitat loss.

Causes of Threat: Unknown.

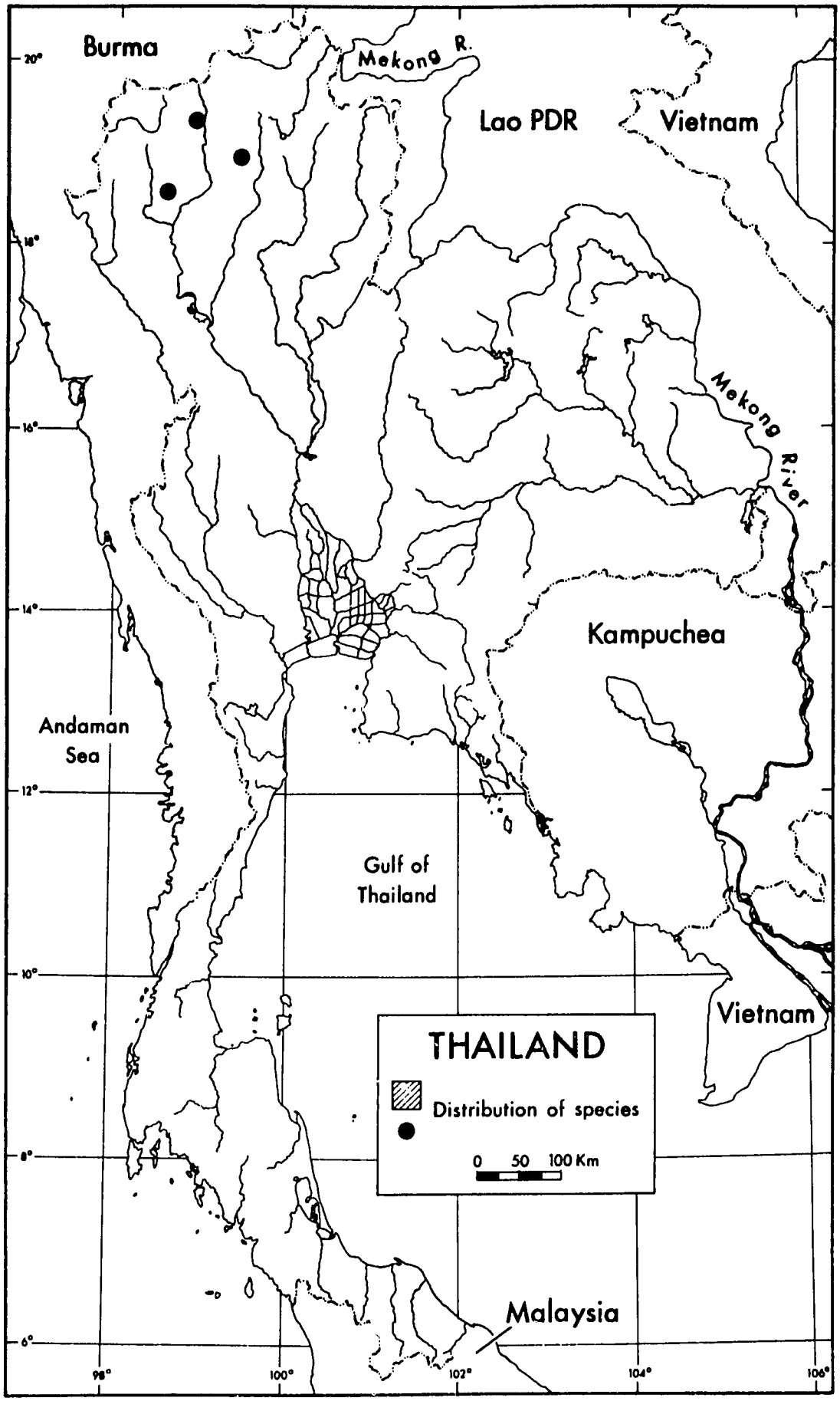
Responses to Habitat Modification: Though none are documented, presumably the former practices of slash-and-burn agriculture followed by fallow forest regeneration benefitted Hume's pheasants by maintaining a mosaic of cover types, much as did local fires prior to man's presence. Now that high human population densities demand more intensive human land use, reversion to forest is prevented and nutrient-poor former agricultural land is burned annually to maintain *Imperata* grassland for cattle grazing. This reduction of the habitat mosaic to large areas of prairie presumably destroys the habitat required by Hume's pheasant.

Demographic Characteristics: A clutch of eggs contains 6 to 10 eggs (Ali and Ripley 1969).

Key Behaviors: The species readily adapts to captivity (Delacour 1951), facilitating captive propagation.

Conservation Measures Taken: Doi Suthep-Pui is a Nonhunting Area, and Chiang Dao is a Wildlife Sanctuary. A captive breeding stock of the western subspecies of Hume's pheasant has been established at the Pheasant Trust, Norwich, England, the Rangoon Zoo, Burma, and other places. The captive population in Europe, Japan, and North America numbered 559 birds in 1976 (IUCN Red Data Book 1977).

Conservation Measures Proposed: Doi Suthep-Pui has been proposed as a National Park. Formal protected status should be considered at Doi Lang Ka also. Our observation of about 10 hunters combing the woodland 100 m from a manned guard station in the forest of Doi Suthep-Pui shows that improved enforcement is needed to protect wildlife once the proposed national park becomes a reality. In addition, people living in some national parks in northern Thailand are converting the fire or slash-and-burn habitat mosaic into extensive prairie; this practice will have to be controlled if wildlife is to be protected in national parks. A field survey is needed to determine if Hume's pheasants survive in their historical range or are present in other areas of montane habitat in northern Thailand. After the current status of the species is documented, specific management steps can be proposed.



Syrmaticus humiae

Burmese gray peacock pheasant

Polyplectron bicalcaratum (Linnaeus 1758)

Aves, Galliformes, Phasianidae

Status: Threatened.
CITES (1979): Appendix II.
IUCN (1979): Threatened.
WARPA (1972): Rare.

Population Size and Trend: Unknown but surely declining. The species is common in suitable habitat (Beebe 1926, Smythies 1953). Though it is very secretive, Beebe once saw 13 in a walk of 6-8 km.

Distribution and History of Distribution: The gray peacock pheasant occurs in India (Sikkim and Assam), Bhutan, Burma, northern and western Thailand, southern China, northern Lao PDR and Vietnam, and Hainan (Delacour 1951). In Thailand this species lives in the northern plateau, the northern part of the Petchabun plateau, and the western and peninsular provinces south to Prachuap Khiri Khan (Deignan 1963). Its distribution has been reduced and fragmented by deforestation.

Geographical Status: Thailand is on the southern edge of the species' range.

Habitat Requirements and Habitat Trend: The gray peacock pheasant lives in evergreen forest and bamboo jungle from near sea level to 1800 m elevation. It uses very dense cover and rarely ventures into openings. Nests are on the ground in dense undergrowth. The diet consists of leaves, grain, seeds, berries, fruits, insects and their larvae, and snails (Beebe 1926, Smythies 1953, Ali and Ripley 1969). Much habitat has been lost.

Vulnerability of Species and Habitat: The birds are easily trapped, and their habitat is vulnerable to deforestation.

Causes of Threat: Deforestation is the major threat to this species.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch usually contains 2 eggs but can have up to 5. Incubation takes 21 days (Ali and Ripley 1969).

Key Behaviors: Incubation is by the hen only. The mating system is apparently monogamy, at least within a breeding season, as the birds routinely are seen in pairs when not alone. The species escapes danger by running and is so wary that shooting is ineffective even with the aid of a dog (Ali and Ripley 1969). Breeding is from March to June in India and earlier in Burma (Smythies 1953, Ali and Ripley 1969).

Conservation Measures Taken: Hunting and export are regulated by Thai law (WARPA 1972). The species has been reported at Nam Nao National Park (IUCN 1979) and Doi Chiang Dao Wildlife Sanctuary (Deignan 1945). It is easy to keep in captivity.

Conservation Measures Proposed: The gray peacock pheasant probably occurs in other parks and sanctuaries; these should be surveyed by persons familiar with the species' call. Research is needed to determine whether populations persist where harvested.

Malay brown peacock pheasant

Polyplectron malacense (Scopoli 1786)

Aves, Galliformes, Phasianidae

Status: Endangered.
CITES (1979): Appendix II.
WARPA (1972): Rare.

Population Size and Trend: Unknown but surely declining. Though many authors consider the species rare or uncommon, this may be because of the birds' secretive habits and remote habitat. Beebe (1926) found this to be one of the most difficult to locate but not the rarest of the Malaysian pheasants.

Distribution and History of Distribution: The Malay peacock pheasant occurs in southeastern Burma, peninsular Thailand and Malaysia, Sumatra, and Borneo (Delacour 1951). Its distribution has been greatly reduced and fragmented by deforestation.

Geographical Status: Thailand is the northern part of the species' range.

Habitat Requirements and Habitat Trend: This peacock pheasant lives in primary, lowland, tropical forest, up to 300-900 m (Beebe 1926, Medway and Wells 1976). Very little of this habitat remains in Thailand.

Vulnerability of Species and Habitat: The birds are shot and trapped. Their habitat is highly vulnerable to deforestation.

Causes of Threat: Deforestation.

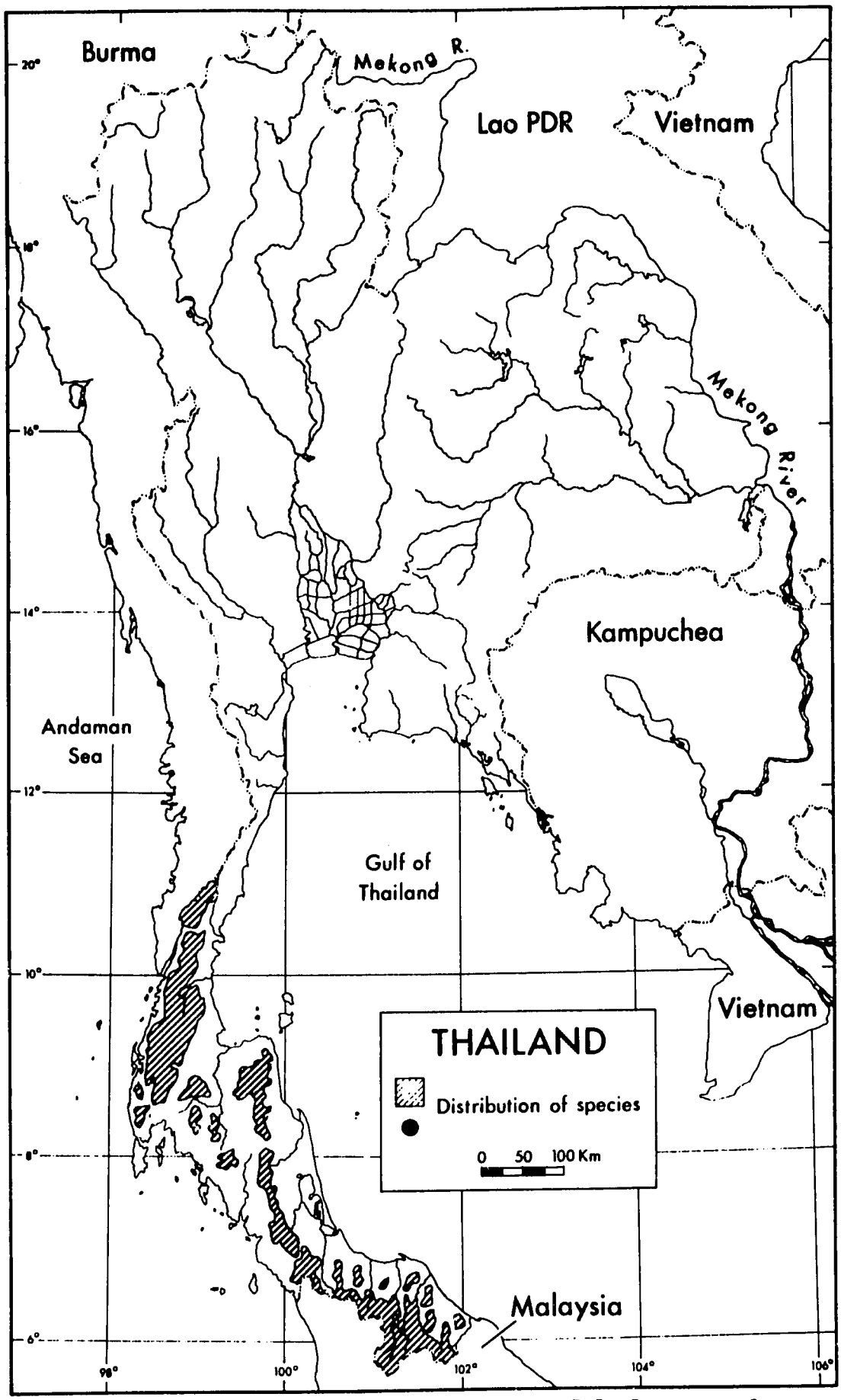
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Malay peacock pheasants usually are seen alone or in pairs, not in larger groups (Beebe 1926).

Conservation Measures Taken: Hunting and export are regulated by Thai law (WARPA 1972). This species is very difficult to keep in captivity (Delacour 1951).

Conservation Measures Proposed: The only hope for the survival of this species in Thailand is well-protected lowland forest. The national parks and wildlife sanctuaries of the South need to be examined for the presence of peacock pheasants.



Polyplectron malacense

Great argus pheasant

Argusianus argus (Linnaeus 1766)

Aves, Galliformes, Phasianidae

Status: Threatened.
CITES (1979): Appendix II.
WARPA (1972): Rare.

Population Size and Trend: The great argus is common, though rarely seen, in suitable habitat (Beebe 1926, Delacour 1951, Smythies 1953, Holmes 1973). Populations are surely declining because of habitat loss.

Distribution and History of Distribution: The species occurs in Burma from Tavoy south, peninsular Thailand south of Prachuap Khiri Khan, peninsular Malaysia, Pangkor Besar, Sumatra, and Borneo (Delacour 1951, Smythies 1953, Deignan 1963). Its range is much reduced and fragmented by deforestation.

Geographical Status: Thailand is most of the northern part of the species' range.

Habitat Requirements and Habitat Trend: The great argus lives in primary and secondary tropical forest up to 1200 m. It frequents dry hills and avoids swamp forest (Beebe 1926, Delacour 1951). Very little of this habitat remains in Thailand. The diet consists of fruit, insects, slugs, and snails (Beebe 1926).

Vulnerability of Species and Habitat: Territorial males are easily trapped (Beebe 1926). The habitat is highly vulnerable to deforestation.

Causes of Threat: Deforestation.

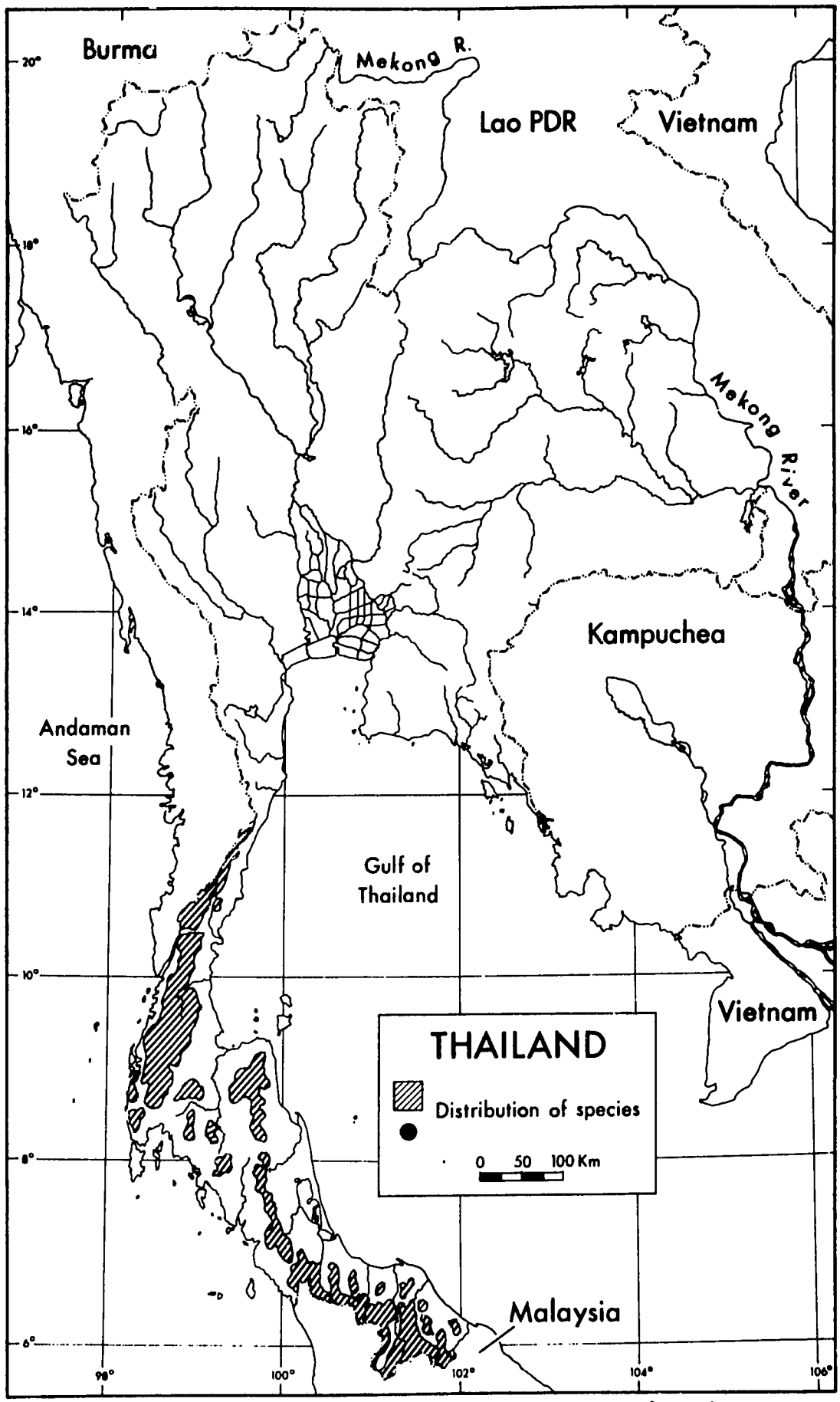
Responses to Habitat Modification: That argus pheasants can live in secondary forest is shown by their abundance in forest recovering from the eruption of Krakatoa on the tip of Sumatra (Beebe 1926).

Demographic Characteristics: The clutch contains 2 eggs, and incubation takes 24-25 days. The birds become sexually mature when 3 years old. The longevity record in captivity is 30 years (Delacour 1951). The breeding season continues over most of the year except for the 2-3 months of molting, and downy chicks have been found in February and August in peninsular Malaysia (Beebe 1926). However, because young do not reach full size until over a year old (Delacour 1951), probably a female can nest only once a year unless the clutch is lost.

Key Behaviors: Both sexes are solitary and territorial except during brief periods of courting and mating. Males maintain individual dancing grounds by clearing live and dead vegetation from an area about 4 m in diameter. The birds feed in the morning and evening and go to water in mid-morning. The rest of the time males are on or near their display areas, where they call day and night to attract females. Males move to very dense forest when molting (Beebe 1926, Davison *in* Smythies 1953).

Conservation Measures Taken: Hunting and export of the great argus is regulated by Thai law (WARPA 1972). The species occurs in the following national parks (NP) and wildlife sanctuaries (WS): Khao Luang NP, Khlong Nakha WS, Khao Banthat WS, and Ton Nga Chang WS (IUCN 1979). Few individuals are bred in captivity (Delacour 1951).

Conservation Measures Proposed: It would be valuable to census the calling males in the parks and sanctuaries of southern Thailand in preparation for management planning, plus proposed sanctuaries (Khao Phra Thaeo, Khlong Phraya, and Sakayo Kuwing Labu). The most effective conservation measures would be maintenance of existing protected areas and establishment of the proposed sanctuaries. The impact of trapping males on their display grounds should be measured, perhaps by call-count density estimates of protected versus unprotected populations. Because only the males are vulnerable to trapping, (assuming that surplus males without territories exist) populations should be able to sustain some harvest without loss of reproduction. Limits on the level of harvest must be retained, in harmony with the species' slow reproductive rate.



Argusianus argus

Green peafowl

Pavo muticus Linnaeus 1766

Aves, Galliformes, Phasianidae

Status: Threatened.
CITES (1979): Appendix II.
IUCN (1979): Threatened.
IUCN Red Data Book (1979): Vulnerable.
WARPA (1972): Rare.

Population Size and Trend: Once widespread and common, the peafowl has become rare or locally extirpated throughout its range in Southeast Asia. In Thailand it is now seen rarely and is considered to be in danger of extirpation (Deignan 1945, IUCN 1968, Lekagul and Cronin 1974, IUCN Red Data Book 1979, B. King personal communication).

Distribution and History of Distribution: Once found throughout Thailand below 900 m except in the central valley of the Chao Phraya and the southeastern provinces, *P. muticus* is now probably most abundant in the mountains of the north. It ranges from northeastern India east through Burma, Yunnan in southern China, Thailand, the Lao PDR, Vietnam, Kampuchea, peninsular Malaya (where possibly extirpated), and Java. Curiously, it is not known from Sumatra or Borneo (Delacour 1951, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976, IUCN Red Data Book 1979).

Geographical Status: Peafowl populations in Thailand are central in the species' overall range.

Habitat Requirements and Habitat Trend: In Thailand this bird is found primarily in lowland forest from sea level to 900 m. In southern China it is found as high as 1400 m. It uses a wide variety of habitats, including open forest, which it prefers, and riverbanks, coastal scrub, teak, tea and coffee gardens, forest edges and clearings, dense secondary growth near shifting agriculture, and other areas. It tends to avoid dense, unbroken forest and the heavily settled river deltas of the Irrawaddy, the Chao Phraya, the Mekong, and the Red. The diet in China was described by Cheng (1963) as follows: "Its eating habits are omnivorous. It likes to eat berries, pears, and other fruit, also rice-grain and seedlings, grass seed, etc.; besides these, crickets, dragonflies, small moths, etc., and frogs and lizards, etc., are also eaten." There are also reports of green peafowl eating termites (Deignan 1945, Gibson-Hill 1949, Madoc 1950, Delacour 1951, Cheng 1963, Deignan 1963, Ali and Ripley 1969, Hoogerwerf 1969, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976, IUCN Red Data Book 1979).

Vulnerability of Species and Habitat: Its habits of nesting on or near the ground and of foraging on the ground in open areas probably make it conspicuous to human predators, as do its far-reaching vocalizations. In areas of India where the animals are held sacred and not molested they become tame and frequent the haunts of man. In the rest of their range they are very shy. These giant pheasants are attractive, even more so than their more common Indian congener, *P. cristatus*, and are widely kept as pets. Their feathers alone are worth a good deal in local markets. There is an active trade in live birds

(Delacour 1951, Cheng 1963, Ali and Ripley 1969, Hoogerwerf 1969, Medway and Wells 1976).

Causes of Threat: Overhunting threatens to eliminate this species from Thailand. Hunters intensively trap it for the feather and pet trade and villagers take it as food. McClure and Chaiyaphun (1971) noted 62 individuals for sale in Bangkok's Sunday Market between November 1966 and December 1968. In the past Thailand has exported live birds (178 in the period 1962-1971, for example), a practice now forbidden by Thai law (IUCN 1968, McClure and Chaiyaphun 1971, Royal Forestry Department 1972, WARPA 1972).

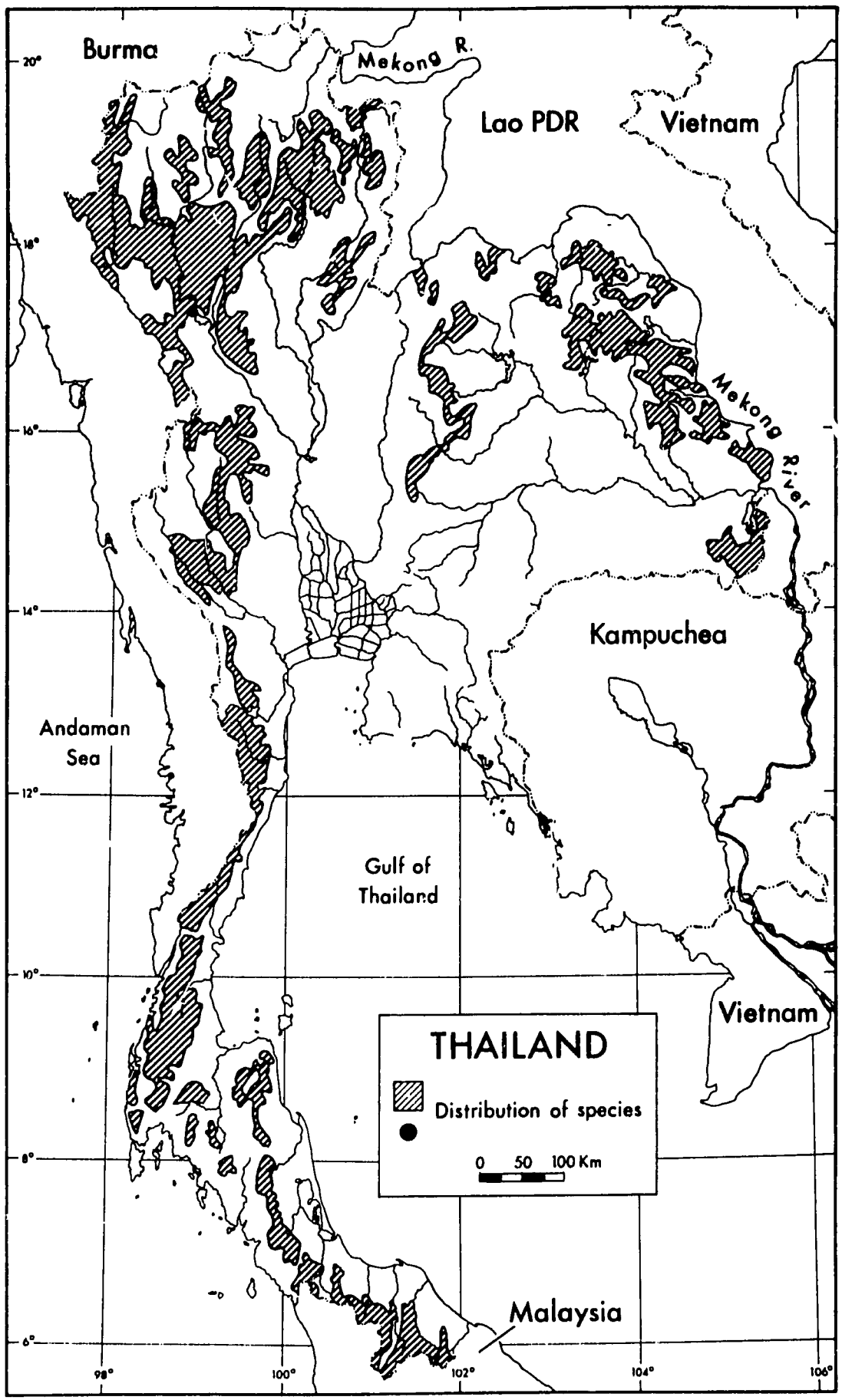
Responses to Habitat Modification: Green peafowl benefit from some forms of habitat alteration, such as the clearing of patches in forests, but conversion of native habitat to heavily settled agricultural areas is sufficient to exclude the species.

Demographic Characteristics: The breeding season in Thailand is unknown. The birds nest July to October in Java, March to May (with some as late as September) in Burma, June to August in southern China, and January to April (and some July-September) in India. The usual clutch size is 3-6 eggs. Incubation lasts about 28 days. The birds grow slowly. Females begin to mate and lay eggs at 22 months age. The birds do not get their adult plumage until age 3 years and may live to be 20-25 if unmolested. Captives lay up to 40 eggs per year (Smythies 1953, Cheng 1963, Ali and Ripley 1969, Hoogerwerf 1969).

Key Behaviors: The specific epithet designated by Linnaeus, muticus ("mute"), is a misnomer. The birds' vocalizations, given most frequently at dawn and dusk, carry for a great distance. Foraging activity, mostly terrestrial, also is crepuscular. Single birds, pairs, and small flocks (often harem/family groups) are seen. During the heat of the day the fowl rest in vegetative cover on the ground. At night they roost, often communally, in the tops of such trees as palms and pines, often as high as 25-30 m. They run rapidly and prefer to run downhill or hide in brushy cover when danger threatens, but will also fly into trees to escape. The surviving peafowl in Southeast Asia are very alert and shy. Males attract harems of 2-5 females in many places. The mating behavior has been described in detail (Delacour 1951, Ali and Ripley 1969). Males of this species are famous for their strutting displays. The hen alone incubates the eggs and cares for the young (Deignan 1945, Smythies 1953, Cheng 1963, Hoogerwerf 1969, Lekagul and Cronin 1974).

Conservation Measures Taken: Thai law (WARPA 1972) controls hunting and export of this species. Green peafowl are reported to occur in the following National Parks (NP) and Wildlife Sanctuaries (WS): Kao Kitchakut NP, Phue Khieo WS, Khao Soi Dao WS, Phu Wa WS, Phu Miang-Phu Thong WS, Ton Nga Chang WS, Salawin WS, and Khun Yuan (proposed) WS (IUCN 1979). There have been recent, unconfirmed reports of this bird in Tarutao Marine National Park in Changwat Satun (IUCN Red Data Book 1979).

Conservation Measures Proposed: Management officials in areas where peafowl are known to survive should keep their requirements for secluded nightroosts, open forest, and escape cover in mind when considering burning regimes, logging operations, and other forestry procedures. In Thailand and around the world these impressive birds have been kept as captives for some time. They breed well in captivity but require shelter on colder nights in temperate regions. The different races of *P. muticus* readily crossbreed in captivity and will outbreed with *P. cristatus* and many other phasianids if allowed. Though there are at least 500 captive *P. muticus* in the world, indiscriminate crossing between the distinct subspecies (Delacour et al. 1928, Delacour 1949) has made the captive stock undesirable as a source for any future restocking efforts. Therefore, efforts should be undertaken in Thailand to procure wild breeding stock of the two Thai subspecies for captive propagation before they are extirpated altogether. Thailand should strictly enforce its laws on hunting and export and initiate surveys to identify the surviving wild populations (Delacour 1951, Cheng 1963, Hoogerwerf 1969, IUCN Red Data Book 1979).



Pavo muticus

Nok karien, eastern sarus crane

Grus antigone sharpii (Linnaeus)

Aves, Gruiiformes, Gruidae

Status: Extirpated from Thailand. The eastern subspecies (sharpii) is endangered.
IUCN (1968): Rare.
WARPA (1972): Rare.

Population Status and Trend: The decline of sarus cranes has culminated in its extirpation from Thailand, where the last records were in 1965 (Boonsong Lekagul in Walkinshaw 1973). A single pair of sarus cranes was reported to persist on Luzon, Philippines, in 1979, but a field survey failed to confirm its presence, indicating extirpation from the Philippines (Madsen 1980a). The eastern subspecies "is definitely gone from Malaysia and the Philippines, it has not been confirmed in Thailand in the last decade, [is] reported gone from Burma..., and no information [is available] from Laos, Cambodia, or Vietnam, although the human turmoil in such areas undoubtedly claimed large birds of open land habitats. The subspecies is established in northern Australia as of 1964 and now numbers in the hundreds" (George Archibald personal communication).

Distribution and History of Distribution: The western subspecies is reported from Pakistan, Kashmir, India, Nepal, Assam, Bangladesh, and Burma. The eastern subspecies is known from Assam, Burma, Thailand, southern Lao PDR, Kampuchea, southern Vietnam, and Luzon; vagrants have occurred in the Malay Peninsula, and a free-ranging population has been established in Queensland, Australia (Walkinshaw 1973). Records in Thailand are as follows: Northern--the open plains and savannas near Chiang Rai, Chiang Saen, Chiang Mai, Fang, and 10 km north of Ban Chong; Central--near Phu Kradeung in Changwat Loei, at Thung Salaeng Luang National Park near Phitsanilok, Sara Buri, Pathum Thani, the Mae Nam Ping valley from Nakhan Sawan to Kamphaeng Phet, and Changwat Rat Buri and Phet Buri; Eastern--the open plains near Surin; Southern--the open plains near Bandon, several places in Changwat Trang, near Sawi Bay south of Chumphon, and north of Songkhla Lake (Riley, 1938, Deignan 1945, Madoc 1950, Boonsong Lekagul in Walkinshaw 1973, Walkinshaw 1973, Lekagul and Cronin 1974).

Geographical Status: Thailand was in the center of the range of the eastern subspecies.

Habitat Requirements and Habitat Trend: The habitat of the sarus crane is the marshes and wet savannas that are maintained by annual flooding and drought, and periodic fire. Tall grass and other herbaceous vegetation, scattered trees in some areas, minor topographic features, and the seasonally shifting availability of wet and dry sites provide a diverse habitat for cover and foraging. High visibility across this habitat facilitates escape from predators, as does roosting in shallow water at night. Nests are large piles of dead vegetation made from locally available materials. They usually are placed directly on the marsh soil or on dry land, but they float well enough to support the weight of a crane as floodwaters rise. This species is omnivorous with a strongly carnivorous tendency, taking a great variety of insects, reptiles, amphibians, snails, fish, crustaceans, marsh plant tubers and corms, grain from ripe rice plants or from harvested fields, and green shoots of grasses, including young rice plants (Riley 1938, Deignan 1945, Ali and Ripley 1969, Walkinshaw 1973, Madsen 1980a).

Vulnerability of Species and Habitat: The habitat of the sarus crane is ideal for conversion to rice agriculture by draining the marshland and/or artifically regulating water levels. Consequently most good habitat has been destroyed. This species can use rice paddies as alternative habitat if not hunted, and this is widely the case in India, where the cranes are informally protected because people like them and consider it bad luck to kill cranes. Sarus cranes in India, which are not threatened by humans, become remarkably tame. Likewise, young cranes in Thailand formerly were sold as garden pets. The last crane known to be exported from Thailand was in 1962 (Royal Forestry Department 1972). When one member of a mated pair is killed or wounded, the mate refuses to escape and is added to the hunter's bag. Following nesting, the cranes lose their flight feathers in August, and at this time cranes in the Philippines were captured with ropes (McGreggor 1909, Deignan 1945, Madoc 1950, Ali and Ripley 1969, Walkinshaw 1973, Madsen 1980a).

Causes of Threat: Conversion of marshes to rice paddies and intensive hunting caused the extirpation of sarus cranes from Thailand.

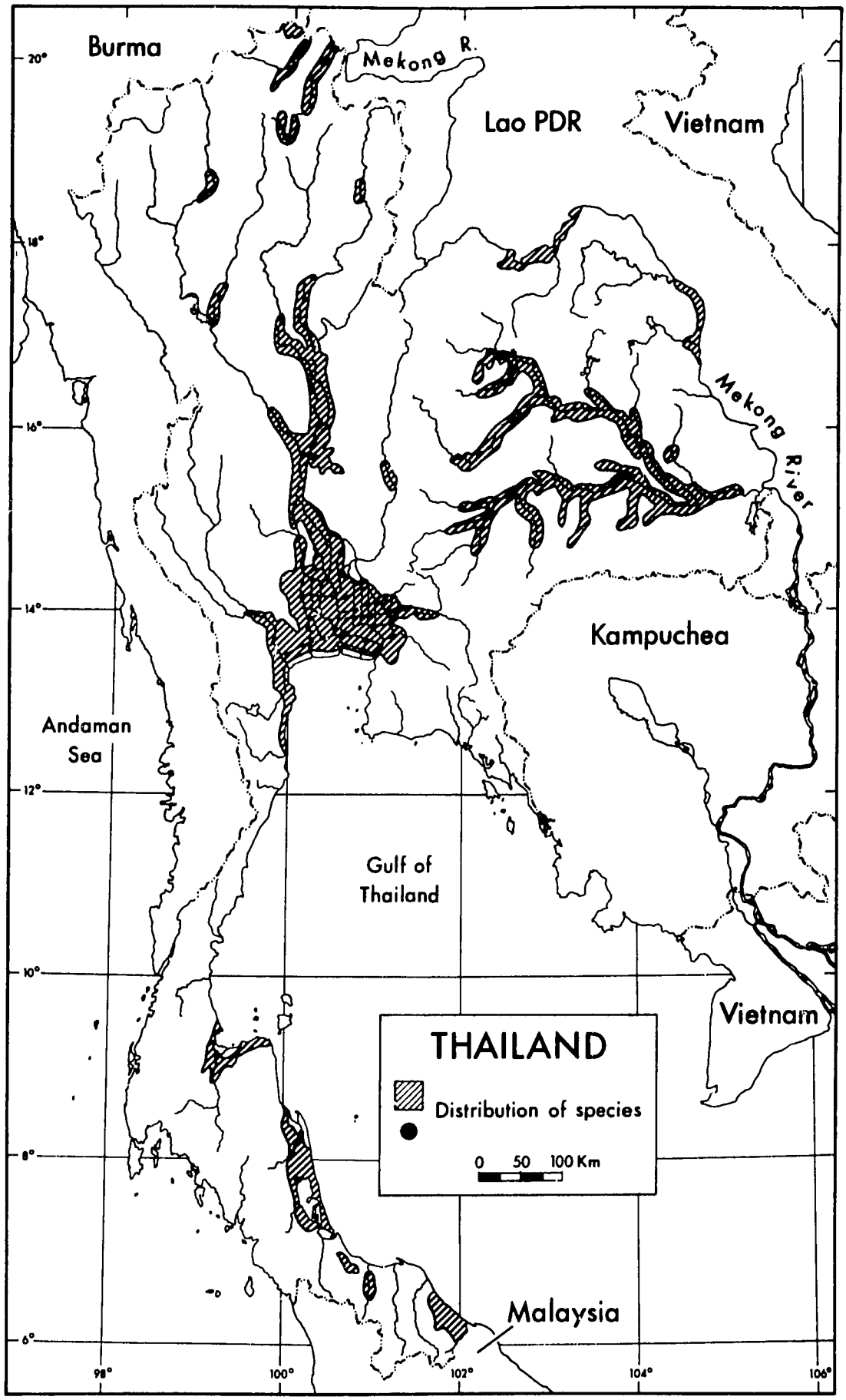
Responses to Habitat Modification: Sarus cranes use rice paddies and feed and nest in close proximity to roads, railroads, and human activities if not threatened by people or other predators.

Demographic Characteristics: Clutches contain 1-3 eggs but normally 2. However, the parents seldom raise more than 1 young. The young receives parental care for at least 10 months. When the adult pair begins breeding again, the subadults flock together. Birds become sexually mature at 34 months of age and thereafter nest annually (Walkinshaw 1973, Madsen 1980a).

Key Behaviors: Sarus cranes pair and remain together for life. Nesting begins at the onset of the monsoon season (June-September in India), so young are hatched at a time when marsh habitat is extensive. Reproduction may be curtailed in years of extreme drought. Local migrations occur in some regions or in drought years (Deignan 1945, Walkinshaw 1973).

Conservation Measures Taken: The species, though extirpated, remains protected by the Wild Animals Reservation and Protection Act of 1972, which prohibits hunting and allows export only with special permission from the Wildlife Advisory Committee of the Wildlife Conservation Division. The individual in the Dusit Zoo, Bangkok (our observation), is of the nonendangered subspecies antigone (Virach Chantrasmi personal communication). A captive population of this subspecies is kept by the International Crane Foundation, Baraboo, Wisconsin, USA.

Conservation Measures Proposed: The sarus crane could be reintroduced into Thailand, perhaps from Australian stock, if all necessary steps could be fully implemented. Much expertise has been developed in connection with the whooping crane recovery work of the International Crane Foundation and the U.S. Fish and Wildlife Service. General needs for a reintroduction program in the Philippines were given by Madsen (1980b). The remaining wetlands in Thailand could be inventoried to determine if sufficient crane habitat is available. The area would need to be acquired and managed as a refuge.



former range of Grus antigone sharpii

Spotted greenshank

Tringa guttifer (von Nordmann 1835)

Aves, Charadriiformes, Scolopacidae

Status: Endangered.
USFWS (1980a): Endangered.
CITES (1979): Appendix I.
IUCN Red Data Book (1977): Indeterminate.
IUCN (1979): Threatened.
MAB (1979): Endangered.

Population Size and Trend: All authors consider the spotted greenshank to be uncommon or rare. The species is apparently disappearing (Red Data Books of USSR and Japan, in Nechaev 1978). 50-60 birds were seen on the breeding ground at Sakhalin Island (Austin and Kuroda 1953). Migrant flocks of 39 were recorded in Korea (Fennell and King 1964) and up to 90 in Malaya (Medway and Nisbet 1966), but most reports are of one or a few individuals.

Distribution and History of Distribution: The spotted greenshank breeds on Sakhalin Island, USSR (Kuroda 1936), apparently at the mouth of the Okhota River near Okhotsk, Khabarovsk Territory, USSR (Von Nordmann 1835), and possibly elsewhere in northeastern Siberia (IUCN Red Data Book 1977). Migration and overwintering occur over a wide area of eastern and southeastern Asia, including the Amur and Ussuri basins of eastern Siberia, Japan, Korea, China, Taiwan, Hong Kong, Hainan, Thailand, Malaya, Singapore, Borneo, Philippines, Burma, Tibet, Assam, and Bangladesh (Smythies 1953, Ali and Ripley 1969, King and Dickinson 1975, IUCN Red Data Book 1977). All Thailand records are from the western shore of the Gulf of Thailand (Deignan 1963, Lekagul and Cronin 1974). Recent sightings (1979 and 1980) have been made at Bangpoo, Samut Prakan, Krabi, and Khao Sam Roi Yot (Boonsong Lekagul personal communication).

Geographical Status: Thailand provides a small portion of the migratory or winter range of the species.

Habitat Requirements and Habitat Trend: During migration and winter, spotted greenshanks occur on mudflats along seacoasts, at river mouths, and in grassy meadows near streams (Vaurie 1965, Ali and Ripley 1969). Nesting habitat on Sakhalin Island is in sparse larch forest, and nests are built on the tree crotches from 2.3-4.5 m above the ground. The young are reared in the nearby marshes along the coast (Nechaev 1978) No habitat trends are known. The diet of specimens from Bangladesh

included small mudfish, crustaceans, molluscs, and insect larvae (Ali and Ripley 1969).

Vulnerability of Species and Habitat: The small breeding area and use of two adjacent habitats for rearing young suggest high vulnerability of breeding habitat.

Causes of Threat: Many authors have commented that reasons for the rarity of the species are unknown. Likewise, reasons for the reputed decline are unknown.

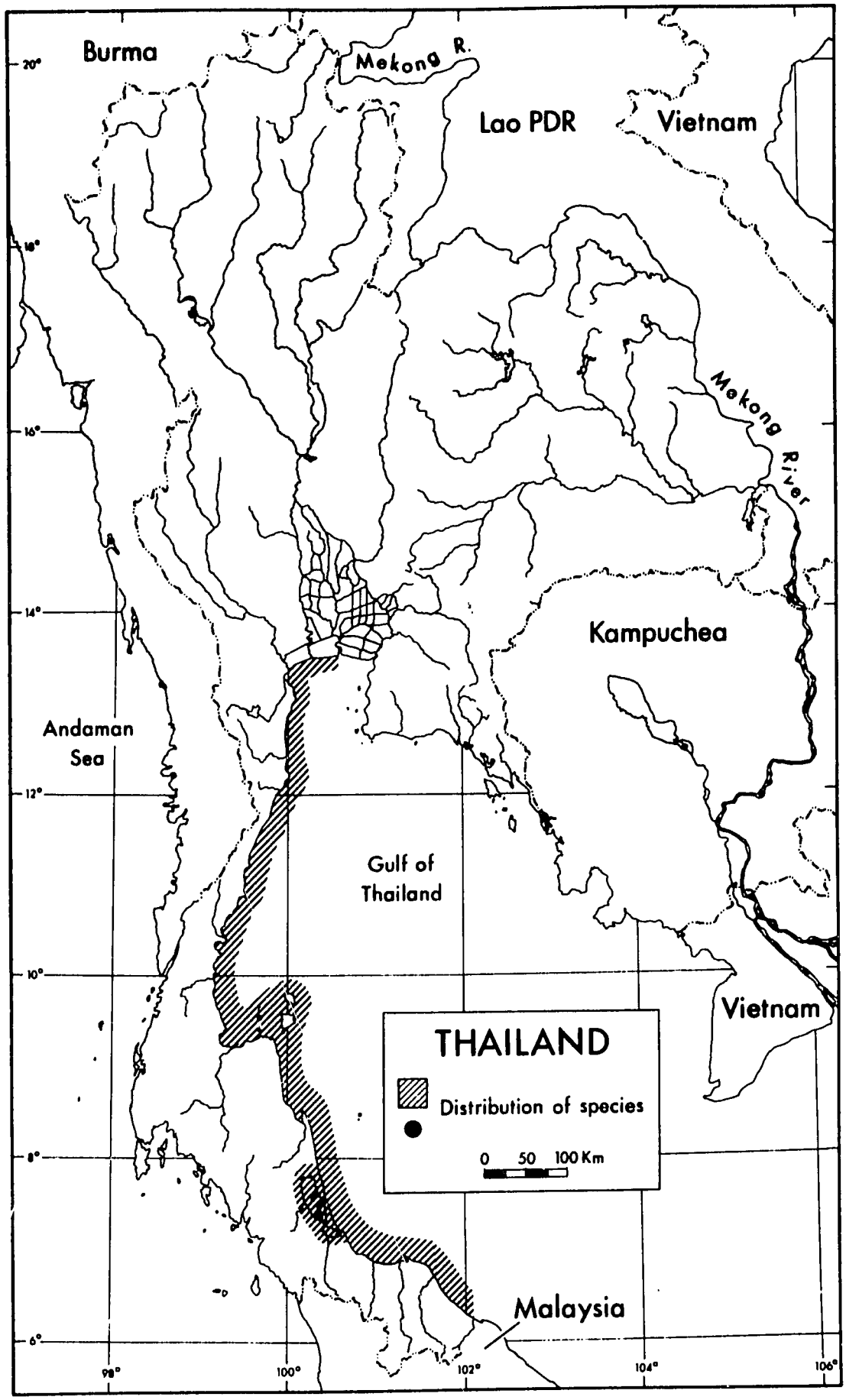
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Clutches each contain 4 eggs, which are incubated by both female and male (Nechaev 1978).

Key Behaviors: Nesting and incubation occur during June. Within a day or two of hatching, the young are moved from the larch forest to coastal marshes (Nechaev 1978). During migration and winter, spotted greenshanks occur in mixed flocks with similar-looking common greenshanks and redshanks, and hence they are easily overlooked.

Conservation Measures Taken: Legal protection in Japan (IUCN Red Data Book 1977) may prevent birds there from being eaten.

Conservation Measures Proposed: Protection of the breeding birds and their habitats would be the most effective steps. In view of the species' rarity in Thailand and the difficulty of identifying this bird, no Thailand-oriented conservation measures are proposed.



Tringa guttifer

Asian dowitcher, snipebilled godwit

Limnodromus semipalmatus (Blyth 1848)

Aves, Charadriiformes, Scolopacidae

Status: Threatened.
IUCN (1979): Threatened.
IUCN Red Data Book (1977): Rare.

Population Size and Trend: This dowitcher is nowhere numerous in its wide range. It occurs in Thailand only as a rare migrant. A recent increase in sightings in Hong Kong suggests that numbers are increasing, but there has been no supporting evidence from elsewhere (Lekagul and Cronin 1974, Webster 1976).

Distribution and History of Distribution: This large wader breeds in several small, widely separated localities in northern Asia and migrates south in winter. The breeding range includes the Argun River valley in Transbaikalia, northeastern and central Mongolia (especially the shores of Lake Oroknor), an area near Tsitsihar in Manchuria, and the valley of the Irtysh River near Tara and the valley of the Ob in the Barnual region of Siberia. In winter it has been seen as a migrant in China, eastern India, Japan, the Philippines, central Annam, Hong Kong, central and peninsular Thailand, Malaya, Burma, the Greater Sundas, northern Australia, Indonesia, and even as far west as Aden (Jorgensen 1949, Paige 1964, Ali and Ripley 1969, Crawford 1972, Lekagul and Cronin 1974, King and Dickinson 1975, White 1975, Medway and Wells 1976, IUCN Red Data Book 1977). Eight individuals were seen at Samut Sakhon in 1981 (Boonsong Lekagul personal communication).

Geographical Status: The Asian dowitchers seen in Thailand are winter migrants from the north.

Habitat Requirements and Habitat Trend: In north-central Asia it breeds in wetlands, meadows, and grassy floodplains below 800 m elevation. Over its winter range in southern Asia it has been seen inland at elevations as high as 1500 m, but most records are from mudflats along seacoasts, the muddy banks of estuaries and large rivers, and coastal marshlands. It has been seen in the Singapore prawn ponds. It feeds on worms and other invertebrate denizens of the mud (Paige 1965, Ali and Ripley 1969, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976).

Vulnerability of Species and Habitat: The coastal areas this species prefers are heavily used by humans. Its large size makes it conspicuous to hunters.

Causes of Threat: Habitat modification by man is probably one of the main reasons that this species is now rare throughout its wide winter range.

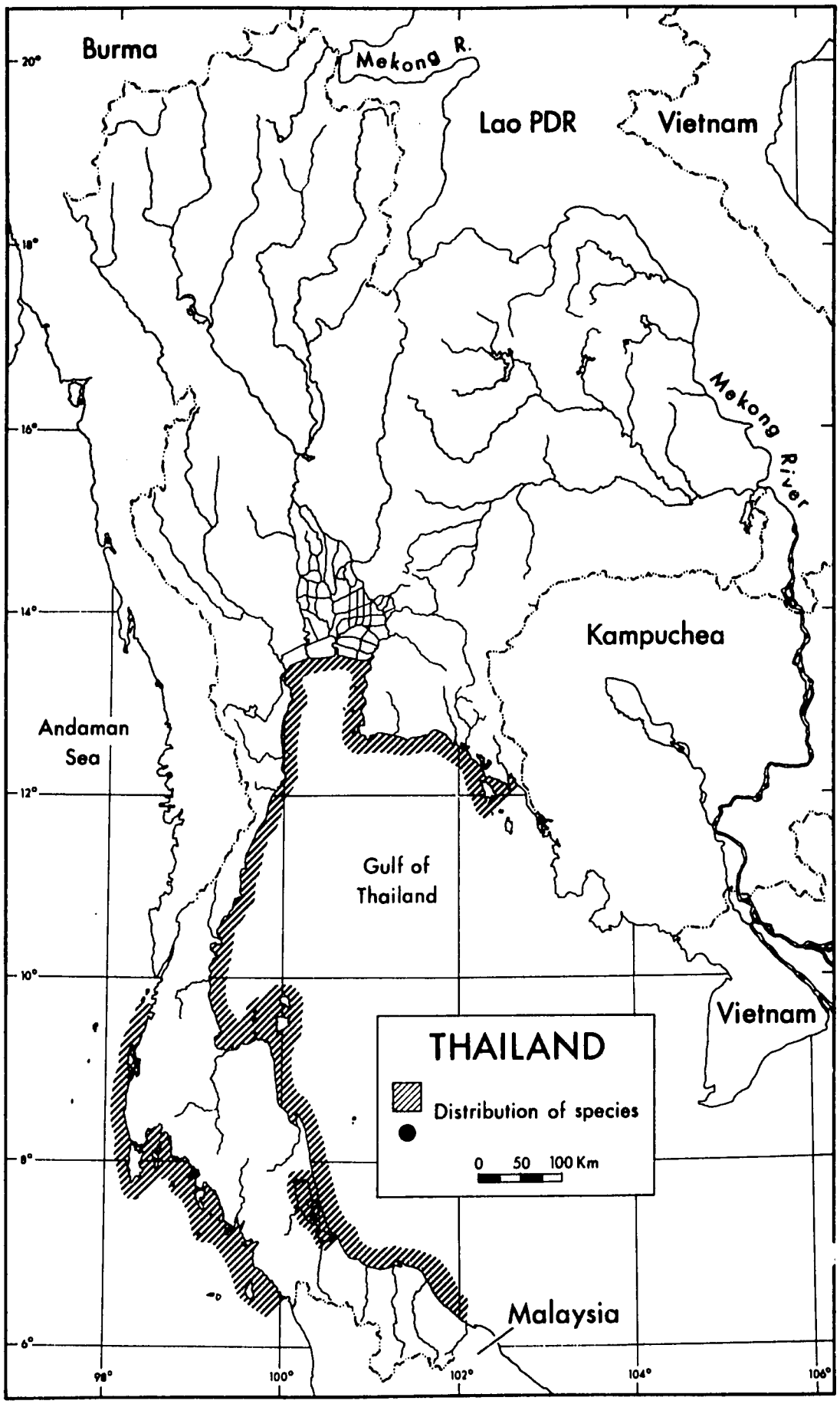
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The typical clutch size is 2 eggs (La Touche 1931-34).

Key Behaviors: L. semipalmatus is usually silent. Its vocalization is very quiet. When breeding it aggregates in colonies of 10-20 pairs. The nests are made of grass. Outside of its breeding range single birds or pairs are the rule, but Medway and Nisbet (1967) reported a flock of 27 at the mudflats at Tanjung Belanak in Perak, Malaysia. The timing of migration is poorly understood. Its earliest arrival in Malaysia is 4 August. Specimens have been seen as late as April or May at the mouth of the Mai Nam River in Changwat Surat Thani and the coast of Changwat Nakhon Si Thammarat (La Touche 1931-34, Riley 1938, King and Dickinson 1975, Medway and Wells 1976, IUCN Red Data Book 1977).

Conservation Measures Taken: None.

Conservation Measures Proposed: As with other such wide-ranging species, any conservation measures considered need to be international in scope. Cooperative banding studies among nations this bird visits are needed to elucidate its migration patterns. Although this is the only Limnodromus reported from Thailand, biologists should be trained to distinguish it from other scolopacids so that it is not overlooked. If any regular wintering localities are discovered in Thailand, the coastal habitat and wetlands in that area should be preserved.



Limnodromus semipalmatus

Chinese crested tern

Sterna zimmermanni Reichenow 1903

Aves, Charadriiformes, Laridae

Status: Endangered, possibly extinct.
IUCN (1979): Threatened.
IUCN Red Data Book (1977): Indeterminate.

Population Size and Trend: This bird was noted in Thailand when three males were taken on 22 November 1923. There have been no published records of it anywhere since 1937 (Medway and Wells 1976, IUCN Red Data Book 1977). However, Atsuo Tsuji and Pilai Poonswad (personal communication) report seeing 10 individuals at Libong Wildlife Sanctuary, Changwat Trang, on 22 July 1980.

Distribution and History of Distribution: The Chinese crested tern bred in summer along China's east coast and wandered south in winter to southeastern China, the Philippines, the Moluccas, Borneo, and the east coast of peninsular Thailand. The three Thai specimens referred to above were taken in coastal waters off Changwat Nakhon Si Thammarat (Deignan 1963, King and Dickinson 1975, Medway and Wells 1976, IUCN Red Data Book 1977).

Geographical Status: The Thai records were evidently winter migrants from the north.

Habitat Requirements and Habitat Trend: This bird inhabited coastal shores (Lekagul and Cronin 1974).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Unknown.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: *S. zimmermanni* was evidently a long distance migrant.

Conservation Measures Taken: None.

Conservation Measures Proposed: Thailand should consider passing laws to protect any that might visit the country in the future. China should conduct surveys of the appropriate areas to determine the status of this bird.

Yellow-vented green pigeon

Treron seimundi (Robinson 1910)

Aves, Columbiformes, Columbidae

Status: Threatened.
IUCN (1979): Drastically reduced.

Population Size and Trend: Very little is known about this species. It is said to be drastically reduced (IUCN 1979) but the species has never been noted as common and may have been rare for a long time. The species is known from 2 specimens taken in Thailand (Deignan 1963) and has not been seen recently in peninsular Malaysia (Medway and Wells 1976). King and Dickinson (1975) term the species an uncommon endemic resident.

Distribution and History of Distribution: The yellow-vented green pigeon is known from Vietnam, Annam, and Thailand, but most authors consider it primarily a Malaysian species (King and Dickinson 1975). Though some records have been thought to represent wanderers, the population centers are not clearly identified. Gibson-Hill (1949) noted that the montane records in Perak and Selangor, Malaysia, are of small series of specimens. The 2 reports from Thailand are from Changwat Nan and Bangkok.

Geographical Status: Uncertain.

Habitat Requirements and Habitat Trend: The species has been recorded in mountains, lowlands, mangroves, and on offshore islands (Medway and Wells 1976). It feeds in high trees (Robinson 1928).

Vulnerability of Species and Habitat: Unknown.

Causes of Threat: Unknown.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: In Annam it is reported to move from the mountains to the plains, where it nests in winter (Goodwin 1977).

Conservation Measures Taken: None.

Conservation Measures Proposed: Observers should be alert for this species in montane forest. Too little is known to propose conservation action.

Wedge-tailed green pigeon

Treron sphenura (Vigors 1832)

Aves, Columbiformes, Columbidae

Status: Threatened.
IUCN (1979): Drastically reduced.

Population Size and Trend: Though undisturbed populations in good habitat are common (Ali and Ripley 1969), the species has been drastically reduced in Thailand (IUCN 1979).

Distribution and History of Distribution: The wedge-tailed green pigeon ranges widely from the Himalayas, southwestern China, and northern Lao PDR and Vietnam south to Sumatra, Java, and Lombok. In Thailand the species is documented from the northern plateau south as far as Tak (Deignan 1963, Goodwin 1977).

Geographical Status: Thailand is central in the large range of this species.

Habitat Requirements and Habitat Trend: This species occupies montane evergreen forest from 900-2750 m (Deignan 1945, La Touche 1931-34). Occasional records in lowlands and foothills (Smythies 1953, Ali and Ripley 1969) may be the result of local migration to escape high-elevation winters (Goodwin 1977). Nest are built 6-15 m high in trees. Feeding is on fruits, particularly of figs, myrtles, and mulberries (Ali amd Ripley 1969). Much habitat has been lost to deforestation.

Vulnerability of Species and Habitat: Its habitat is vulnerable to deforestation.

Causes of Threat: The species is threatened by deforestation.

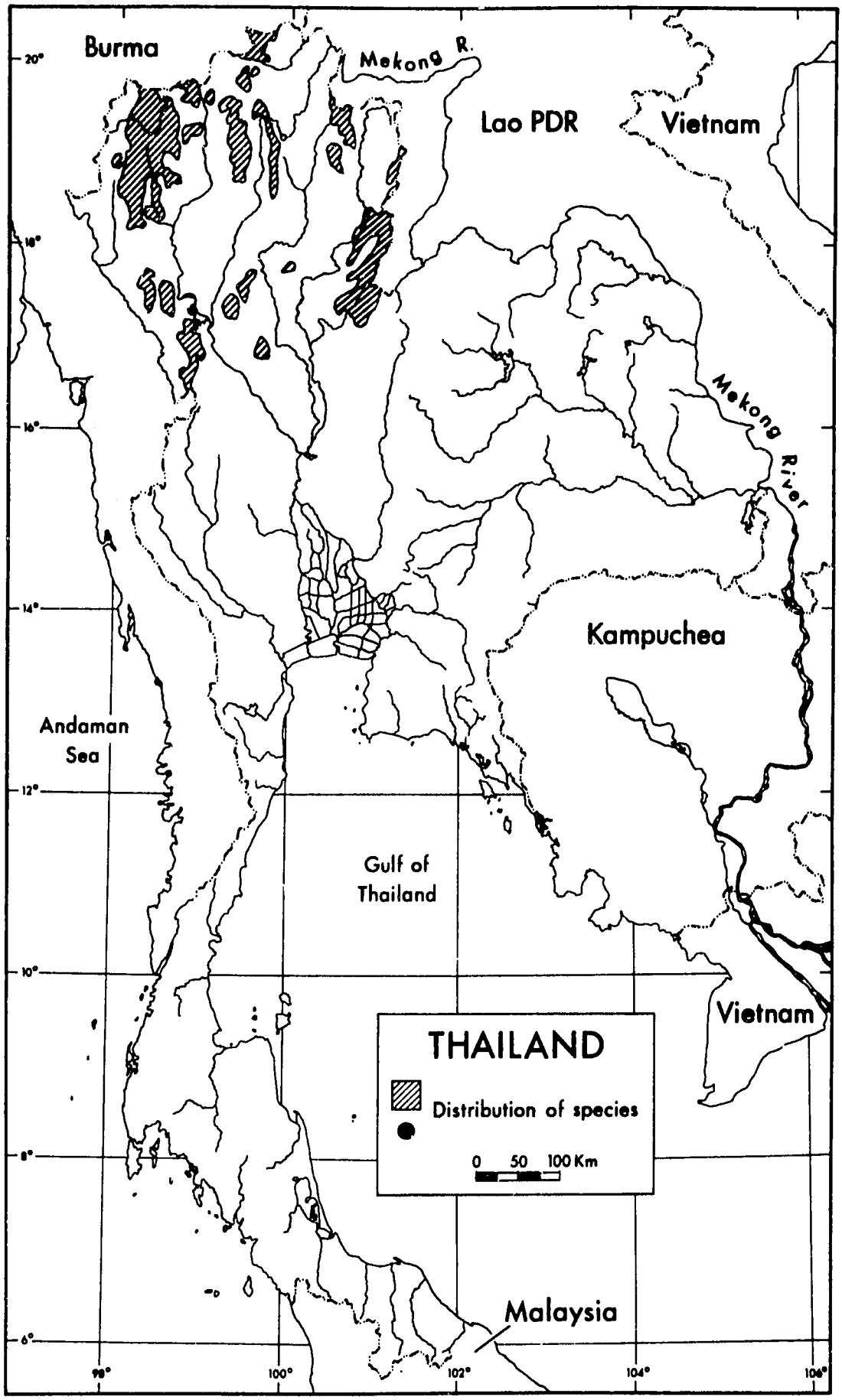
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch contains 2 eggs; in captivity incubation takes 14 days and fledging takes 12 (Goodwin 1977).

Key Behaviors: Both sexes incubate the eggs. Nesting in northern India is from April to August (Ali and Ripley 1969). This species often nests near nesting drongos (Dicrurus), which are notably effective at repelling avian nest predators (Goodwin 1977). The species is locally migratory in northern India and in peninsular Malaysia (Ali and Ripley 1969, Medway and Wells 1976). Green pigeons have a specialized gizzard that grinds the seeds ingested with fruit (Goodwin 1977).

Conservation Measures Taken: The species has been recorded in the proposed Doi Suthep-Pui National Park.

Conservation Measures Proposed: The available habitat could be mapped rather accurately as the remaining forest above 1000 m in the northern plateau, using the classification analysis of LANDSAT imagery recently undertaken by Thailand's National Research Council. Trade in this species should be prohibited, because keeping the birds supplied with fruit in captivity is difficult.



Treron sphenura

Pied imperial pigeon

Ducula bicolor (Scopoli 1786)

Aves, Columbiformes, Columbidae

Status: Threatened.

Population Size and Trend: Populations of this species have not been measured. It is locally common (Brockelman and Nadee 1977) to scarce (Hoogerwerf 1969).

Distribution and History of Distribution: The pied imperial pigeon occurs on coasts and small islands from the Bay of Bengal to New Guinea. Its range includes all of Thailand's coasts and offshore islands (Goodwin 1977). Specific distribution records in Thailand are on Ko Huyong, Chanqwat Phangnga (Dickinson 1966), and Ko Surin Nua, Chanqwat Ranong (Brockelman and Nadee 1977).

Geographical Status: Thailand is a substantial portion of the northern part of the species' range.

Habitat Requirements and Habitat Trend: This species breeds only on small islands but forages more widely to include mangroves on the mainland and coastal woods and plantations. Nests are built on tree or shrub branches. The diet consists of fruits, including mangroves, figs, and nutmegs (Medway and Wells 1976, Goodwin 1977). Substantial areas of coastal mangroves and upland woods have been cleared.

Vulnerability of Species and Habitat: The habitat of this species is vulnerable to deforestation.

Causes of Threat: Cutting mangroves for charcoal and coastal deforestation threaten this species.

Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch consists of a single egg (Goodwin 1977).

Key Behavior: The pied imperial pigeon is highly gregarious, nesting in loose colonies (Goodwin 1977) and at times roosting in the thousands (Smythies 1953). Nesting occurs from December to March in the Andaman and Nicobar Islands, with records in May and July on islands off peninsular Malaysia (Medway and Wells 1976, Goodwin 1977).

Conservation Measures Taken: The Royal Forestry Department now regulates the cutting of mangroves in sets of 30 strips, with 1 cut per year on a 30-year rotation. This should assure the maintenance of reproducing mangroves as a food source.

Conservation Measures Proposed: The species occurs in the proposed Ko Surin Wildlife Sanctuary. Establishing this sanctuary would assure a future for this population. Other offshore islands should be inventoried to determine where key nesting sites occur. Trade should be prohibited, because this fruit-eating species is difficult to keep supplied with food in captivity.

Ashy wood pigeon

Columba pulchricollis Blyth 1846

Aves, Columbiformes, Columbidae

Status: Threatened.
IUCN (1979): Drastically reduced.

Population Size and Trend: The ashy wood pigeon is rare throughout its range, though its secretive habits contribute to that impression (Smythies 1953, Ali and Ripley 1969, Goodwin 1977). Only 2 records have been reported from Thailand (Deignan 1945), so the term "drastically reduced" (IUCN 1979) is inappropriate.

Distribution and History of Distribution: This is a bird of mountain forests. It occurs in Tibet, Nepal, Bhutan, India (Sikkim and Assam), northern Burma, northwestern Thailand, and Taiwan (Ali and Ripley 1969, Goodwin 1977). The 2 records from Thailand are from the summit of Doi Lang Ka (Deignan 1945), and other mountains may be occupied.

Geographical Status: The Thailand population of ashy wood pigeons is on the margin of the range or perhaps disjunct from other populations.

Habitat Requirements and Habitat Trend: This species occupies premontane deciduous and montane evergreen forest, usually at elevations of 1200-3200 m. However it occasionally has been seen in the lowlands (Smythies 1953, Ali and Ripley 1969, Goodwin 1977). Nests are in small forest trees, fairly low. The diet is mainly fruits but also includes acorns, seeds, grain, and snails (Ali and Ripley 1969). Much habitat suitable for this species has been destroyed.

Vulnerability of Species and Habitat: The habitat of this species is vulnerable to deforestation.

Causes of Threat: Deforestation is a threat to this species.

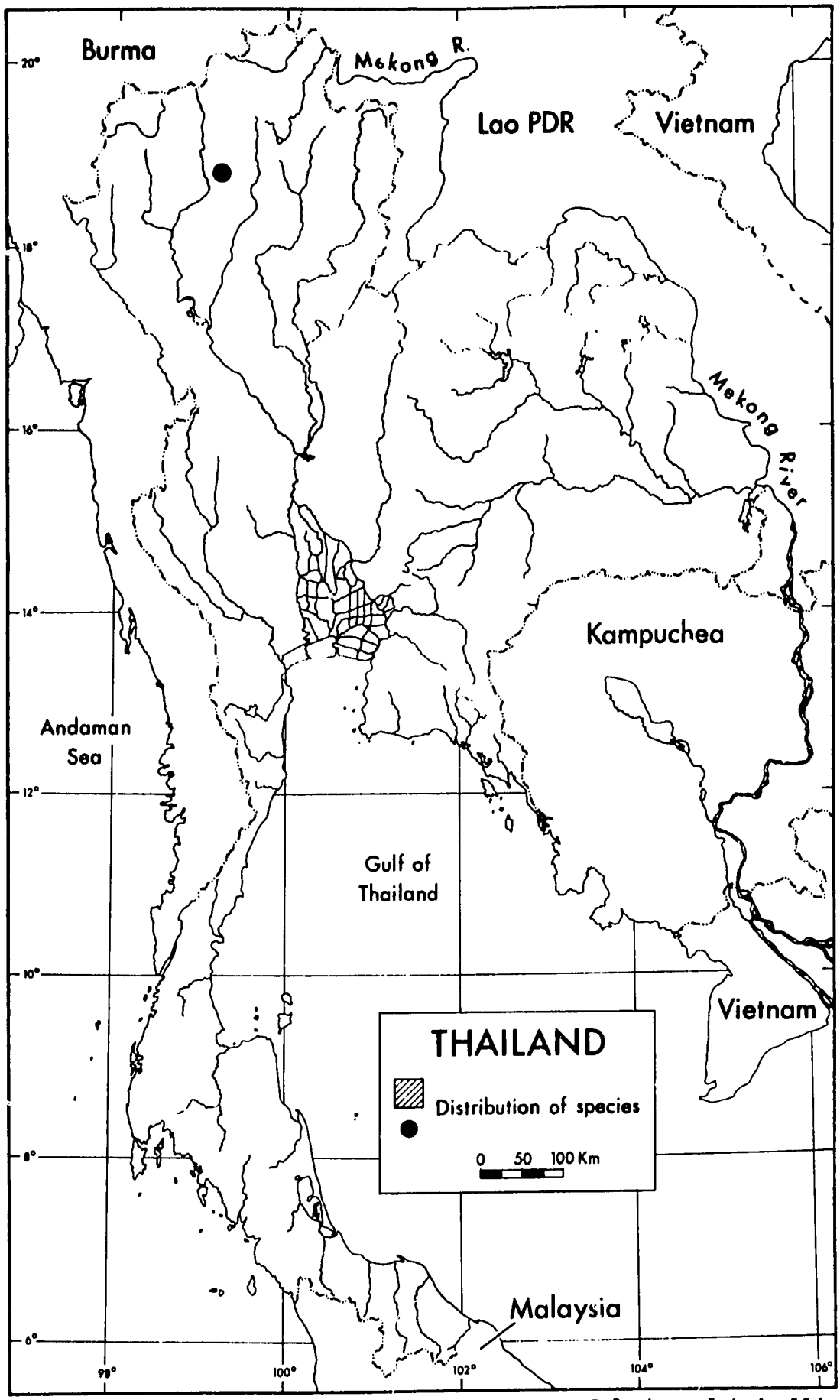
Response to Habitat Modification: Unknown.

Demographic Characteristics: The clutch consists of a single egg (Baker 1913, Ali and Ripley 1969).

Key Behaviors: Ashy wood pigeons forage and rest high in trees, and their flight is silent. As a result, they are seldom observed (Ali and Ripley 1969).

Conservation Measures Taken: None.

Conservation Measures Proposed: Observers need to listen for this species' call, a deep sonorous coo, in the mountains of northern Thailand. More information is needed before specific conservation action can be proposed.



Columba pulchricollis

Pale-capped pigeon

Columba punicea Blyth 1842

Aves, Columbiformes, Columbidae

Status: Threatened.
IUCN (1979): Drastically reduced.

Population Size and Trend: Populations are poorly documented, but most records are from several decades ago (Riley 1938, Medway and Wells 1976), so populations may indeed be drastically reduced (IUCN 1979).

Distribution and History of Distribution: The pale-capped pigeon occurs in eastern India, Bangladesh, Burma, Lao PDR, central Vietnam, Thailand, and peninsular Malaysia. In Thailand its distribution is in the southeast (Changwats Sara Buri and Chon Buri, and the peninsula from Changwats Phet Buri to Satun). Most of the peninsular records are from islands off the west coast. Specific island records are from Ko Muk, Ko Lak, Ko Phuket, and Ko Phra (Riley 1938, Ali and Ripley 1969, King and Dickinson 1975).

Geographical Status: Thailand is near the southern edge of the species' range. Birds appear to be resident in the southeast, but in the peninsula they appear only as winter (January-March) migrants (Riley 1938, Medway and Wells 1976).

Habitat Requirements and Habitat Trend: Pale-capped pigeons live in forest and second growth, including forests interspersed with farmland, from lowlands up to 1600 m elevation. On islands they occur in mangrove as well as upland forest. The diet is of fruit and seeds (including grains). The fruit component partially ties the birds to evergreen forest or at least evergreen undergrowth. Nesting is low, usually 6 m or less, in a bush or bamboo clump (Riley 1938, Smythies 1953, Ali and Ripley 1969). Much lowland forest has been lost.

Vulnerability of Species and Habitat: The habitat of this species is vulnerable to deforestation.

Causes of Threat: Deforestation threatens this species.

Responses to Habitat Modification: Pale-capped pigeons use agricultural land adjacent to forest, but extensive deforestation removes their basic habitat.

Demographic Characteristics: A cluth contains 1 egg (Ali and Ripley 1969).

Key Behaviors: The breeding season is from May to July-August (Ali and Ripley 1969). In peninsular Thailand the species is present from January to March (Medway and Wells 1976). Hence pale-capped pigeons appear to be latitudinal migrants.

Conservation Measures Taken: The pale-capped pigeon was recorded early in this century from what now is Ko Tarutao Marine National Park (Riley 1938).

Conservation Measures Proposed: Research is needed to identify breeding and wintering populations and migration routes. Preserves should be established to support a network of sites that will provide year-round habitat for the species.

Nicobar pigeon

Caloenas nicobarica (Linnaeus 1758)

Aves, Columbiformes, Columbidae

Status: Threatened.
CITES (1979): Appendix I.

Population Size and Trend: The total numbers of this bird are unknown. In Thailand it is a locally common resident on some offshore islands (Lekagul and Cronin 1974).

Distribution and History of Distribution: This island dweller is found from the Nicobar Islands, the Andaman Islands, and the Mergui Archipelago to the Philippine and the Solomon Islands. In Southeast Asia it is found in the islands off Tennaserim in Burma, on Con Son Island off Vietnam, off the coast of Kampuchea, and off both coasts of Thailand, primarily south of the Isthmus of Kra. It migrates or wanders between island groups and sometimes strays to the mainland (Gibson-Hill 1949, Deignan 1963, King and Dickinson 1975, Goodwin 1977).

Geographical Status: The Thai populations are situated near the western limit of the species' range.

Habitat Requirements and Habitat Trend: The Nicobar pigeon is a ground forager in the forests of small islands adjacent to the mainland. These are usually uninhabited by people. It is said to prefer heavy evergreen growth. Brockelman and Nadee (1977) saw it in most of the ravines on the Surin Islands in April of 1976. These large pigeons have impressive abilities to ingest and digest large, whole seeds. They forage in the undergrowth for fleshy fruits, grains, berries, and invertebrates, and for quartz particles to aid in grinding food (Delacour 1947, Gibson-Hill 1949, Wildash 1968, Ali and Ripley 1969, Lekagul and Cronin 1974, King and Dickinson 1975, Goodwin 1977).

Vulnerability of Species and Habitat: Its large size and habit of sometimes forming large breeding aggregations makes this bird vulnerable to hunters. Its reputation for preferring places unsettled by man suggests that it survives best in such places. Its preference for islands in itself adds to the species' vulnerability--a sizeable fraction of the world's endangered and recently extinct birds are insular forms.

Causes of Threat: C. nicobarca is eaten and taken alive by man. Extensive human settlement and deforestation on accessible islands is also a problem. Annual exports from Thailand from 1967 to 1971 were 106, 106, 738, 54, and 249 (Royal Forestry Department 1972). McClure and Chaiyaphun (1974) recorded 352 of these birds for sale at the Bangkok weekend market.

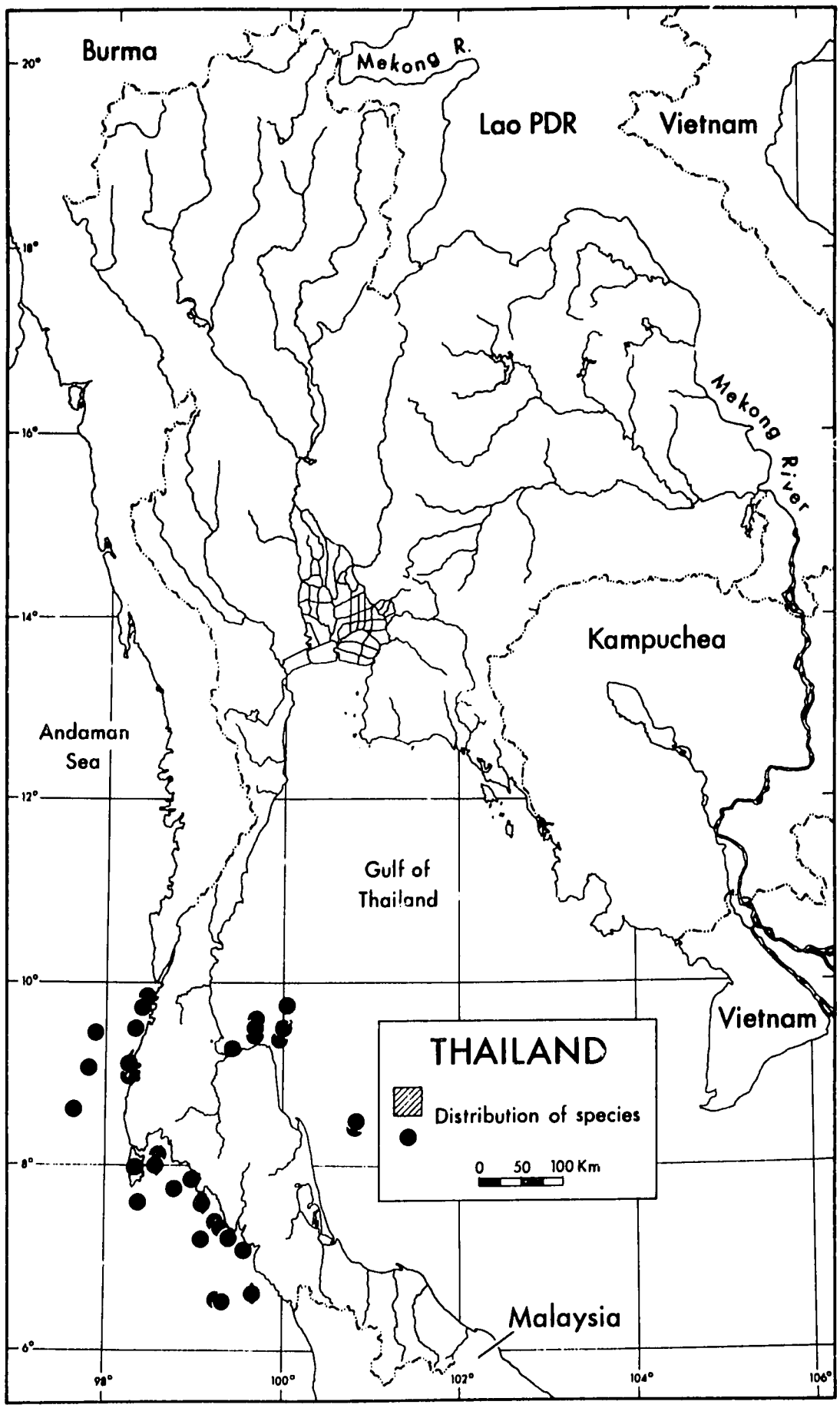
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The usual clutch size is one egg. Nesting in Malaysia has been reported in April, May, and September. In India the birds nest primarily in January through April (Ali and Ripley 1969, Medway and Wells 1976, Goodwin 1977).

Key Behaviors: These ground feeders are shy, quiet, and alert. They are seen singly, or sometimes in flocks up to 20-30. Captives perch during the day and forage nocturnally, but wild individuals are thought to forage diurnally on the dim forest floor. While foraging the bird walks about, kicking at leaves to expose food. C. nicobarica is a swift, powerful flier and is capable of flying long distances without rest. It usually nests in trees or bushes 3-10 m up. There may be several nests in one tree. In the older literature nesting aggregations of thousands of pairs were reported. In captivity both sexes incubate the egg and care for the young (Delacour 1947, Ali and Ripley 1969, Lekagul and Cronin 1974, King and Dickinson 1975, Goodwin 1977).

Conservation Measures Taken: Much island habitat is protected in such areas as Tarutao National Park, where C. nicobarica is known to occur (IUCN 1979). It also occurs in Ko Surin (proposed) Wildlife Sanctuary (Brockelman and Nadee 1977). No Thai law specifically protects the species.

Conservation Measures Proposed: The significant breeding populations on Thai islands need to be identified and protected. Hunting and trade should be monitored and controlled. Forest habitat on islands should be preserved.



maximum potential range of Caloenas nicobarica

Family Bucerotidae - The Hornbills

Introductory Comments

With 13 species of hornbills, Thailand has almost a third of the world's 45 known species. Except where they have been extirpated locally by hunting for food or sale, hornbill populations survive in all of Thailand's remaining forests. These large, long-lived forest birds range widely in their daily searches for food. Many flock and night-roost gregariously, sometimes by the hundreds. They are highly arboreal, feeding in the tree crowns. Hornbills are notoriously omnivorous, eating even bats and fish, but they subsist mainly on small fruits. Their breeding biology is unique. The female seals herself inside a hollow in a large tree far above the forest floor using mud, fruit pulp, and feces. The male feeds her through a narrow slit left in the plug. She remains inside until the young are partially grown (McClure 1970, Lekagul and Cronin 1974, King and Dickinson 1975, Frith and Douglas 1978).

This family is noted for the large bills of its species. With them the birds can deliver a formidable blow. The bills often have accessory casques, larger in males and adults. Unlike other hornbills, the helmeted hornbill, Rhinoplax vigil has a very hard, solid casque that is carved into jewlery and many other items. This "ivory" was an important minor item of commerce in Southeast Asia for many centuries. During and since the Ming dynasty Borneo has supplied China with hornbill "ivory." The tail feathers of several species see much ceremonial use in the region. In Borneo certain peoples have learned to preserve the bills and feathers with the secretions of the bird's own uropygial gland. The birds are sometimes taken alive as pets, but they consume prodigious quantities of food and cannot be "house-broken." More often they are taken as food. Their habit of roosting in large groups make them especially vulnerable to overhunting. Over the centuries hornbills have become prominent in the mythologies of many indigenous peoples (Harrisson 1951).

All hornbills are protected under the Thai Wild Animals Reservation and Protection Act of 1972. The primary threats to the birds are hunting and deforestation. From an original 80 percent, forest cover of Thailand has declined to 53 percent in 1961, 39 percent in 1973, and 25 percent in 1978 (Myers 1980). Large dead trees with cavities are important structural features of the environment for these and many other species. In forest management and reforestation efforts, the value of snags to wildlife always should be borne in mind. As with many other cavity nesters their breeding biology is difficult to study and generally poorly understood. Before sound management practices can be formulated, more research needs to be done on their ecology. Preservation of forest habitat is of the utmost importance to hornbill conservation.

White-crested hornbill

Berenicornis comatus (Raffles 1822)

Aves, Coraciiformes, Bucerotidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: This animal apparently never has been common in Thailand. Lekagul and Cronin (1974) classify it as an uncommon resident.

Distribution and History of Distribution: The white-crested hornbill is known discontinuously from southern Burma, central Annam, southern Vietnam, peninsular Thailand, Malaya, Sumatra, and Borneo. Most published records from Thailand are from Changwat Nakhon Si Thammarat and Changwat Trang (Riley 1938, Deignan 1963, Lekagul and Cronin 1974, King and Dickinson 1975).

Geographical Status: The Thai populations are centrally located in the species' distribution.

Habitat Requirements and Habitat Trend: B. comatus inhabits forest habitat from the lowlands to 1677 m, typically from 120-820 m. Frith and Douglas (1978) recently saw it in "good primary hill forest just inland of Nakhon Si Thammarat." It supplements its fruit diet with lizards, small birds, and other animals (Delacour 1947, Smythies 1953, Glenister 1955, Lekagul and Cronin 1974, King and Dickinson 1975, Frith and Douglas 1978).

Vulnerability of Species and Habitat: Although their wings do not make as much noise in flight as in other hornbills, their raucous vocalizations make them quite noticeable to man.

Causes of Threat: Overhunting and deforestation threaten this bird.

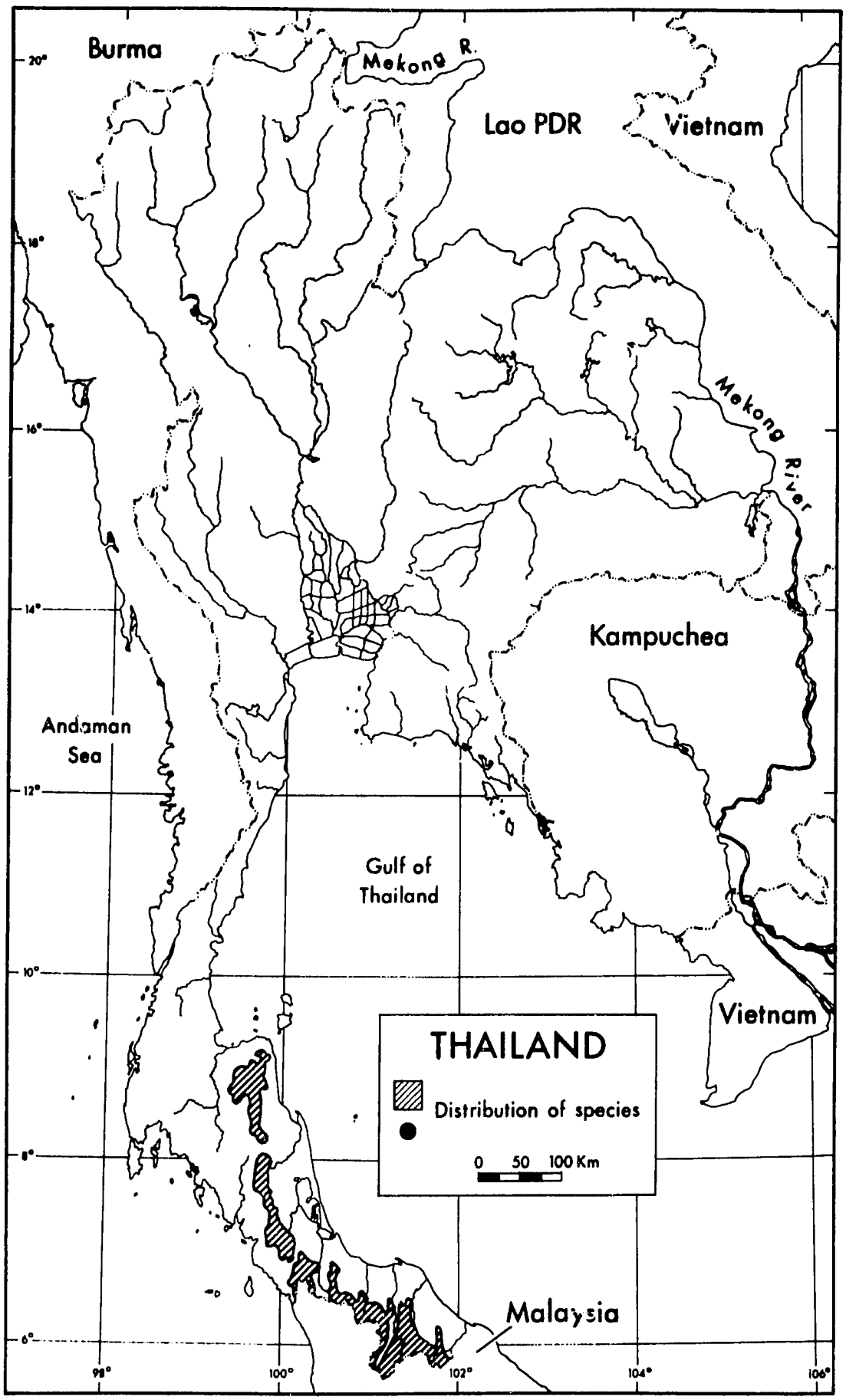
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The breeding habits of this bird in the wild are unknown. Frith and Douglas (1978) purchased 2 post-fledged young in Bangkok on 19 May 1975 (they died within 4 months). It is possible that they came from the same nest.

Key Behaviors: These hornbills have been reported to feed both in the canopy and among dense undergrowth near the ground. They forage in small groups. The group of at least three seen by Frith and Douglas (1978) were flying and perching at the edge of a large, swift mountain river. The nesting behavior has not been described (Smythies 1953, Glenister 1955, Medway and Wells 1976).

Conservation Measures Taken: WARPA (1972) protects the species from hunting and export.

Conservation Measures Proposed: A survey of the forested areas in southern Thailand to determine the status of this species would be most timely. Special attention should be given to the National Parks, Wildlife Sanctuaries, and Non-hunting Areas with intact forest. Hunting should be controlled and forest cover preserved. Research on the basic biology of this bird is needed.



Berenicornis comatus

Brown hornbill, Tickell's hornbill

Ptilolaemus tickelli (Blyth 1855)

Aves, Coraciiformes, Bucerotidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: The total numbers of this bird are unknown. Lekagul and Cronin (1974) consider it to be an uncommon resident in Thailand.

Distribution and History of Distribution: Tickell's hornbill is known from the mountains of northwestern and southwestern Thailand, the Tenasserim range in southern Burma, Lao PDR, northern and central Annam, northwestern Vietnam, Assam, and southwestern China (King and Dickinson 1975).

Geographical Status: The Thai populations are peripheral, lying near the southern limits of the species' distribution.

Habitat Requirements and Habitat Trend: This bird inhabits the tops of tall trees in mature evergreen forest up to 1800 m. It is omnivorous, like other hornbills, and is said to eat wild figs, drupes, berries, insects, and other small animals (Deignan 1945, Smythies 1953, Deignan 1963, Ali and Ripley 1970, Pfanner 1974, Lekagul and Cronin 1974, King and Dickinson 1975).

Vulnerability of Species and Habitat: Their gregariousness and continual vocalizations make these birds conspicuous to hunters. Montane evergreen forest habitat is being depleted at an alarming rate.

Causes of Threat: Overhunting and deforestation threaten this species.

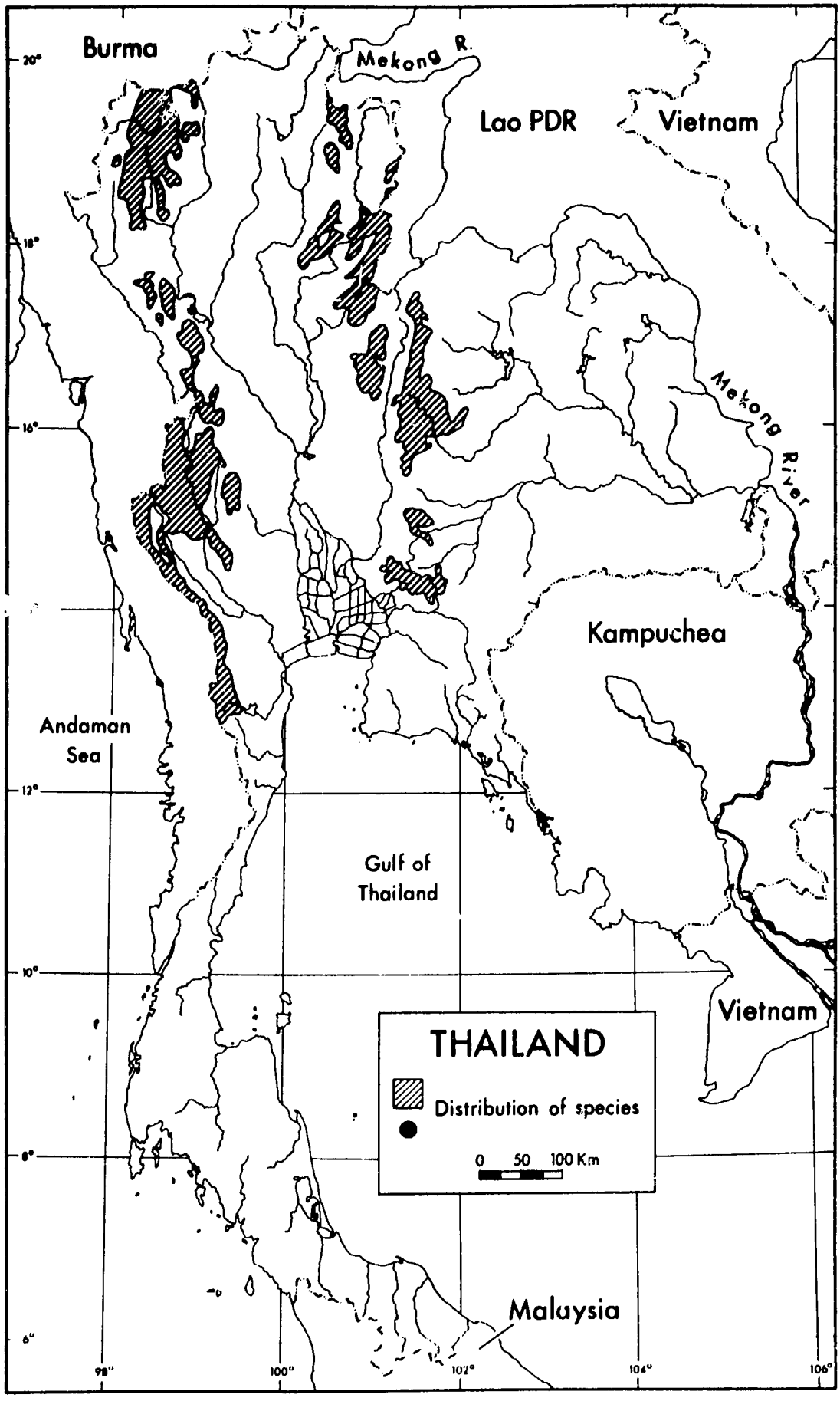
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Breeding has been reported in February and March in Burma and April to June in India. The typical clutch is 3 or 4 eggs. The incubation period is unknown but is thought to be about 24 days (Smythies 1953, Ali and Ripley 1970).

Key Behaviors: These animals feed among the tree crowns in flocks of 8-20 or more. They are very restless, constantly moving within and between trees. They fly in long lines. The flight is relatively noiseless for a hornbill, but not nearly as silent as in Berenicornis comatus. However, they continually vocalize while perching or on the wing. They frequently form mixed-species flocks with other frugivorous birds. They are shy and difficult to approach. Their nest hollows are relatively close to the ground (4-9 m or higher). They sunbathe in typical hornbill fashion (Smythies 1953, Ali and Ripley 1970, Frith and Douglas 1978).

Conservation Measures Taken: Thai law (WARPA 1972) protects the species. The brown hornbill is one of the rarest birds in Khao Yai National Park (Pfanner 1974). A specimen was taken in Phu Kradueng National Park in Changwat Loei in the late 1960's (Dickinson and Chaiyaphun 1973). Deignan (1945) recorded it from what is now Doi Chiang Dao Wildlife Sanctuary and the Doi Suthep-Pui Nonhunting Area.

Conservation Measures Proposed: The staff of forest reserves should assess the current status of this species in their jurisdictions. Hunting should be controlled and forest habitat with proper nesting trees should be preserved.



Ptiloaemus tickelli

Bushy-crested hornbill

Anorrhinus galeritus (Temminck)

Aves, Coraciiformes, Bucerotidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: This species apparently never has been very abundant in Thailand in recent times (Lekagul and Cronin 1974).

Distribution and History of Distribution: Bushy-crested hornbills have been found from the Tenasserim range in southern Burma south through peninsular Thailand to Malaya, Sumatra, and Borneo. Published records from peninsular Thailand include birds from Changwat Nakhon Si Thammarat, Trang, and Phangnga (Riley 1938, Smythies 1953, Deignan 1963, King and Dickinson 1975, Frith and Douglas 1978).

Geographical Status: Anorrhinus in Thailand exists near the northern limits of the species' distribution.

Habitat Requirements and Habitat Trend: This species has been recorded from sea level to 1220 m in the canopy of evergreen forests and in old rubber plantations. An imprisoned nesting female observed in Selangor was fed "Rutaceae (?Evodia); Leguminosae (incl. ?Entada); Fagaceae (Lithocarpus cyclophorus); Sterculiaceae (Sterculia foetida); Sapindaceae (Sapindus rarak); Connaraceae (?Connarus); Palmae" (Medway and Wells 1976). They take a variety of small fruit and berries and readily catch fish. A captive was seen with a magpie robin, Copsychus saularis, which it had killed (Delacour 1974, Smythies 1953, Glenister 1955, Holmes 1973, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976, Frith and Douglas 1978).

Vulnerability of Species and Habitat: Its ability to live in secondary growth, such as in old rubber plantations, may make this species less vulnerable than other hornbills.

Causes of Threat: Overhunting and habitat loss threaten this species.

Responses to Habitat Modifications: These hornbills are capable of surviving in at least some disturbed habitats.

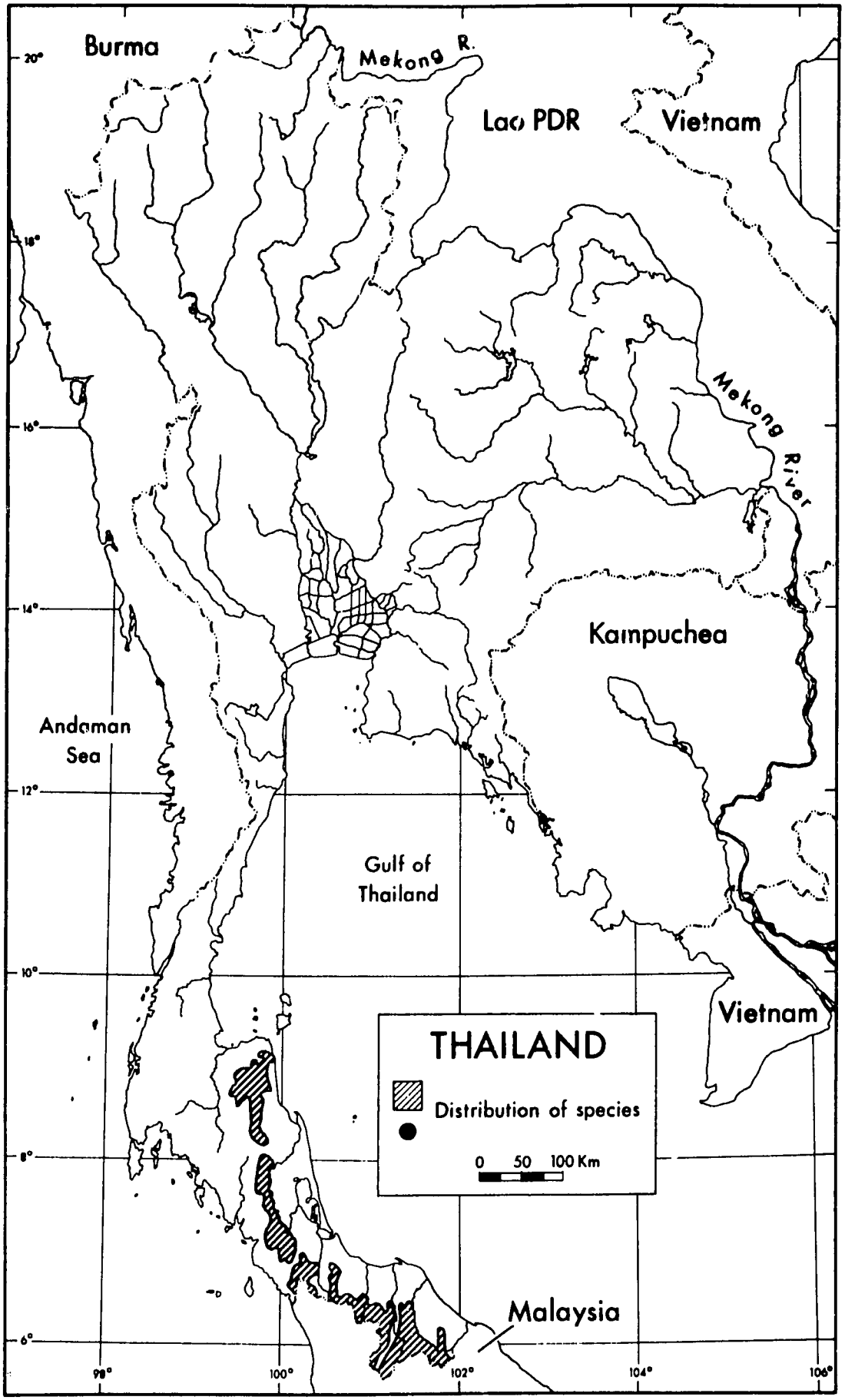
Demographic Characteristics: In Selangor a nest in a hollow tree with two young was active from 21 July to 27 August (Medway and Wells 1976). Frith and Douglas (1978) purchased a fledgling on 19 April 1975 that was still alive as their report went to press. Reproduction in this species was studied by Madge (1969).

Key Behaviors: These birds are usually gregarious, feeding in the treetops in groups of 5-15. Though shy and seldom seen by man they are more frequently heard. Unlike the other captive hornbills Firth and Douglas (1978) kept, this species would bathe in water. At a nest observed in Ampang Forest

Reserve in Selangor, Malaysia, all flock members, including immatures, were seen to feed the nesting female and her young. This social behavior probably enhances the bird's reproductive success (Delacour 1947, Smythies 1953, Holmes 1973, Frith and Douglas 1978).

Conservation Measures Taken: This bird is protected from hunting and export by Thai law (WARPA 1972).

Conservation Measures Proposed: Hunting and trade in this species should be controlled. Where it is found to inhabit protected areas, the forests should be managed with hornbill requirements in mind. The extent to which it is able to thrive in disturbed habitats requires further study.



Anorrhinus galeritus

Rufous-necked hornbill

Aceros nipalensis (Hodgson 1829)

Aves, Coraciiformes, Bucerotidae

Status: Threatened.
WARPA (1972): Rare.

Population Size and Trend: The total numbers of this bird are unknown. Lekagul and Cronin (1974) consider it to be an uncommon resident in Thailand.

Distribution and History of Distribution: This hornbill is known from Nepal, Sikkim, Bhutan, India, Bangladesh, southwestern China, Burma, northwestern Thailand, northern Lao PDR, and northwestern Vietnam, (Ali and Ripley 1970, Lekagul and Cronin 1974, King and Dickinson 1975).

Geographical Status: The Thai populations are peripheral, lying near the southern limits of the species' distribution.

Habitat Requirements and Habitat Trend: A. nipalensis prefers the tall evergreen forest of the higher hills and mountains to an elevation of about 1800 m (Smythies 1953, Ali and Ripley 1970, Lekagul and Cronin 1974). These arboreal animals are primarily frugivorous. Ali and Ripley (1970) described the diet as "large drupes and berries swallowed entire; Dysoxylon sp. and nutmegs (Myristica) are especially favoured."

Vulnerability of Species and Habitat: Their preference for mature evergreen forest makes them vulnerable to deforestation.

Causes of Threat: Overhunting and deforestation threaten this species.

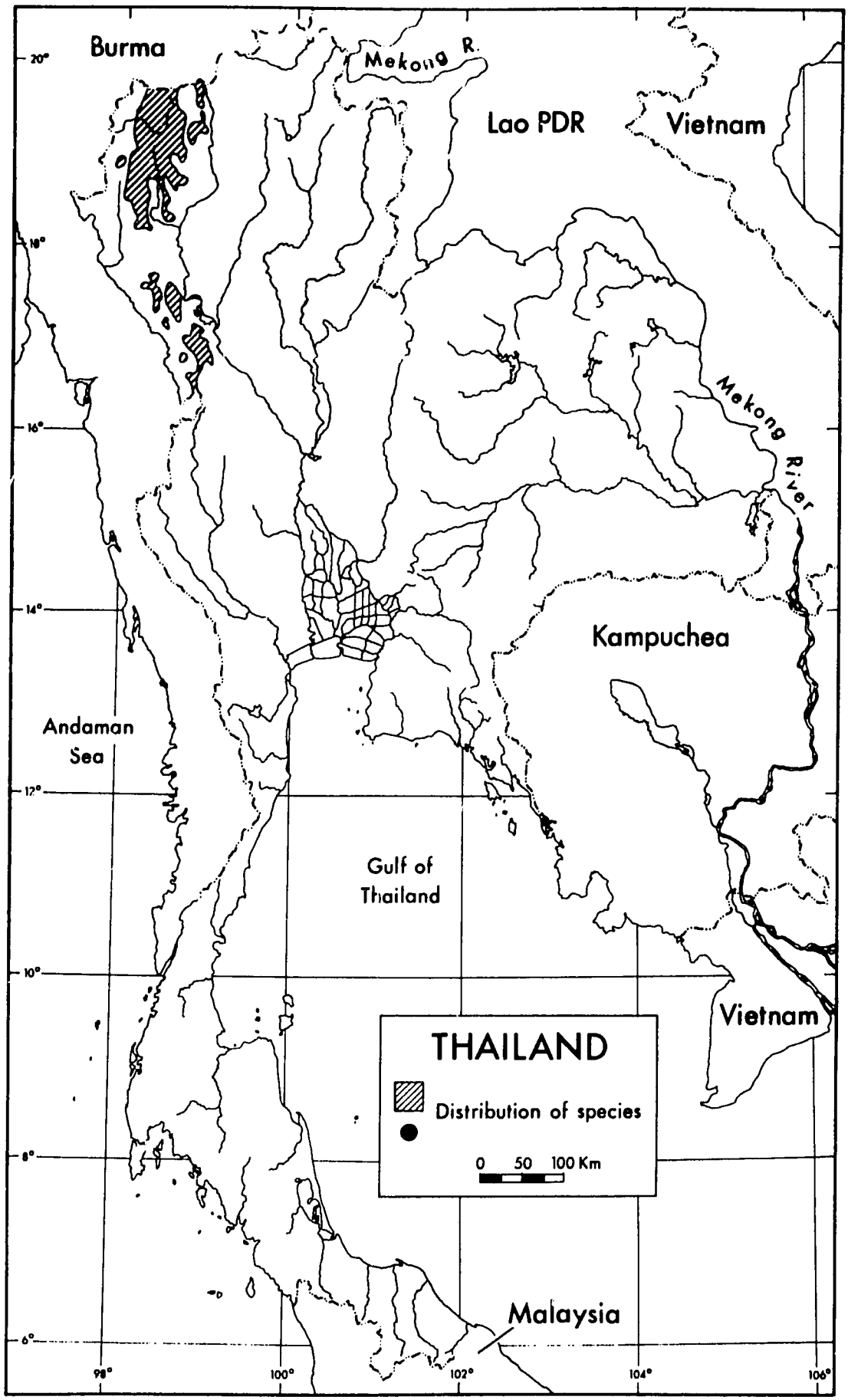
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The normal clutch is 1-2 eggs. Deignan (1945) recorded a male with enlarged gonads taken on Doi Suthep in Changwat Chiang Mai on 22 January. In India the breeding season is primarily in April and May (Ali and Ripley 1970).

Key Behaviors: These birds are normally seen in pairs or small groups up to 4-5 individuals. Although most foraging is done in the tree crowns, the birds are known to descend to the forest floor to feed on fallen fruit. The male has a bizzare and dramatic nuptial display. The nest hollow, usually 10-30 m up the tree, is apparently used year after year (Deignan 1945, Ali and Ripley 1970).

Conservation Measures Taken: Thai law regulates hunting and export (WARPA 1972). The animals have been taken several times in what is now the Doi Suthep-Pui Nonhunting Area (Riley 1938, Deignan 1945). They undoubtedly occur in other forest reserves in the northwestern mountains.

Conservation Measures Proposed: As with other hornbills, hunting should be controlled and forest habitat, including suitable nest trees, should be preserved. Studies on nesting of these and other hornbills are badly needed.



Aceros nipalensis

Rhinoceros hornbill

Buceros rhinoceros Linnaeus 1758

Aves, Coraciiformes, Bucerotidae

Status: Threatened.
CITES (1979): Appendix II.
WARPA (1972): Rare.

Population Size and Trend: Lekagul and Cronin (1974) classified it as an uncommon resident. B. King (personal communication) considers it to be "probably rare at best".

Distribution and History of Distribution: Rhinoceros hornbills are found from southern peninsular Thailand south through Malaya to the Greater Sunda Islands. It has been extirpated from Singapore. In Thailand it is known from Changwat Songkhla south (Riley 1938, Deignan 1963, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976).

Geographical Status: The rhinoceros hornbills in Thailand are at the northern limits of the species' distribution.

Habitat Requirements and Habitat Trend: This bird inhabits the canopy level of forests from the lowlands through the hills to 1220 m. It is omnivorous, feeding mainly on fruits (Gibson-Hill 1949, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976). Forests are, of course, being cleared at an unprecedented rate in southern Thailand.

Vulnerability of Species and Habitat: The flight of this species is loud and reminds many people of the sound of a steam engine. The birds also vocalize while perching and flying. They are moderately gragarious. All of these features make them conspicuous to man. In parts of the Greater Sundas the tail feathers and other parts have ornamental, ceremonial, and economical value (Harrisson 1951).

Causes of Threat: Overhunting and deforestation threaten this species. The nearly complete forest cover of southern Thailand has declined to 42 percent in 1961, 39 percent in 1965, 26 percent in 1972, and 24 percent in 1978 (Myers 1980).

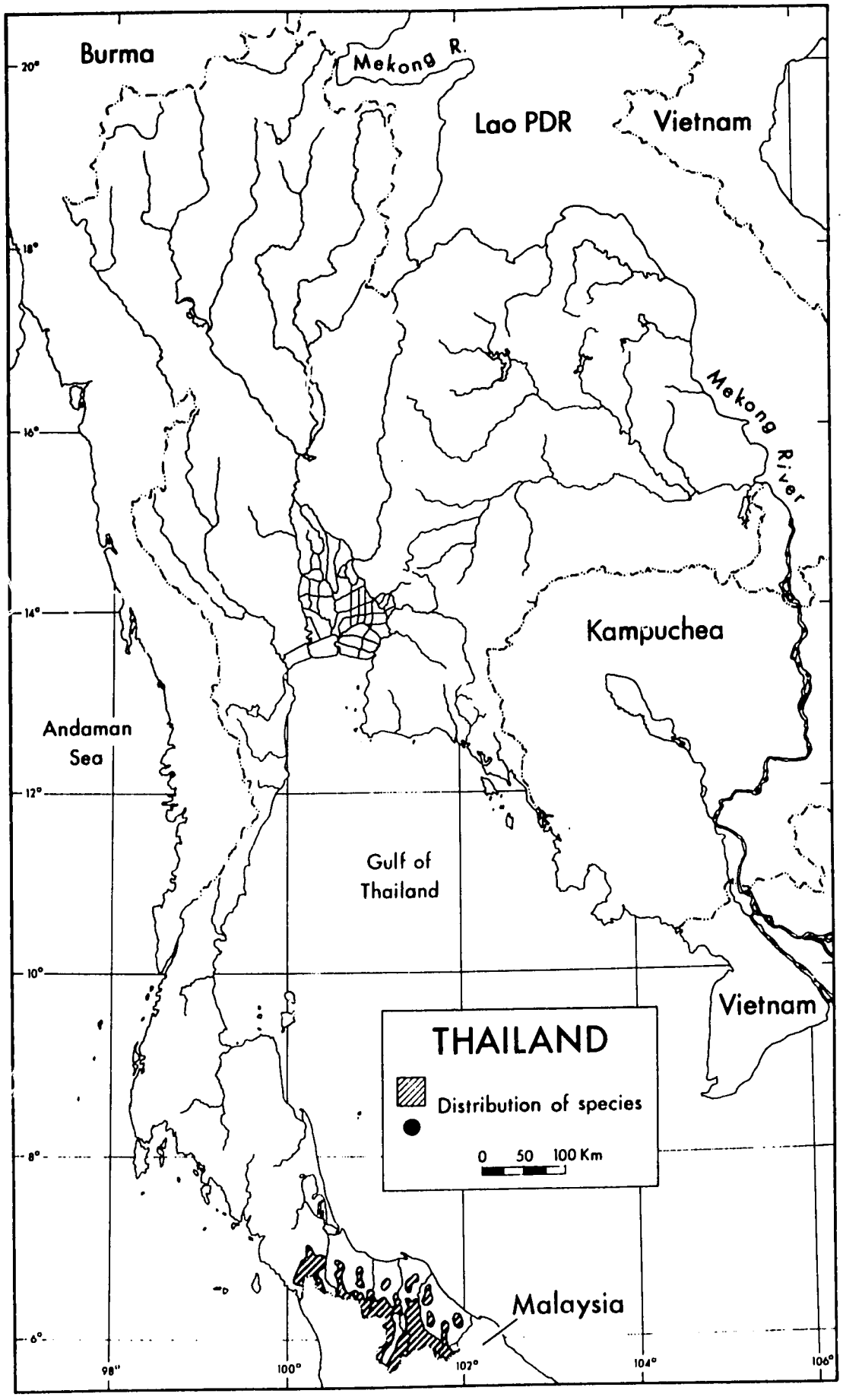
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The breeding biology of this bird in the wild is poorly understood. A nest was seen in early February and a flock containing mostly immatures was seen in late September in Malaya (Medway and Wells 1976). Frith and Douglas (1978) obtained a juvenile, estimated to be four months old on 4 November, from an animal dealer who said the bird was from Changwat Yala.

Key Behaviors: Pairs, small family groups, and flocks up to several dozen are seen in the wild. Within the flocks, many animals fly two by two and may be paired. Groups appear to cooperate in feeding the nesting females and young. As in other hornbills, the young will inflate their air sacks to keep them from being pulled from the nest. One captive juvenile had to ingest feces in order to fully digest some foodstuffs (Medway and Wells 1976, Frith and Douglas 1978).

Conservation Measures Taken: Thai law (WARPA 1972) protects this bird from hunting and export.

Conservation Measures Proposed: A survey of Khao Banthat Wildlife Sanctuary, Ton Nga Chang Wildlife Sanctuary, and the proposed reserves in the far south should be made to determine the status of *B. rhinoceros* in each. Hunting should be controlled and forested areas with suitable nest trees should be preserved.



Buceros rhinoceros

Great hornbill

Buceros bicornis Linnaeus 1758

Aves, Coraciiformes, Bucerotidae

Status: Threatened.
CITES (1979): Appendix I (subspecies homrai ; south of the Isthmus of Kra)
CITES (1979): Appendix II (subspecies bicornis; north of the Isthmus of Kra)
WARPA (1972):

Population Size and Trend: Where suitable habitat remains it is a year round common resident in Thailand. In some areas, such as Khao Yai National Park, it is commonly encountered during most of the year, though less conspicuous in the mating season (Lekagul and Cronin 1974, McClure 1974a).

Distribution and History of Distribution: This bird is known from several disjunct places in India, southwestern China, Bangladesh, Burma, throughout mainland Southeast Asia, Malaya, and Sumatra. It has been found throughout Thailand except in the central valley of the Chao Phraya and much of the northeastern Khorat Plateau (Deignan 1945, Wildash 1968, Ali and Ripley 1970, Lekagul and Cronin 1974, Holmes and Wells 1975, King and Dickinson 1975, Medway and Wells 1976).

Geographical Status: The Thai populations of the great hornbill are central in the species' overall range.

Habitat Requirements and Habitat Trend: B. bicornis is primarily an inhabitant of tall evergreen forest from the lowlands to 2000 m. They are mainly arboreal, but have been known to descend to the ground to feed. They are omnivorous. Figs (Ficus) are the favored food. Nutmegs (Myristica) and many other fruits are eaten, as are insects, reptiles, birds, and mammals. They probably function more as raptors in avian communities than has been thought. They will not drink water except falling rain (Deignan 1945, Gibson-Hill 1949, Deignan 1963, Ali and Ripley 1970, Lekagul and Cronin 1974, McClure 1974a, King and Dickinson 1975).

Vulnerability of Species and Habitat: The flight of these large birds makes a sound which can be heard over great distances. Their vocalizations are also loud. They are especially vociferous at the beginning of the mating season. Some weigh over 3 kg and make an attractive meal for people. The flesh is said to be of excellent flavor. Traditionally the peoples in Thailand and Burma have hunted these for food and feathers. Today they are commonly sold in Bangkok's Sunday Market (Deignan 1945, Smythies 1953, Glenister 1955, Ali and Ripley 1970, McClure 1974a). Annual export of great hornbills from Thailand from 1967 to 1971 were 78, 99, 128, 126, and 176 (Royal Forestry Department 1972).

Causes of Threat: Overhunting and deforestation threaten this species.

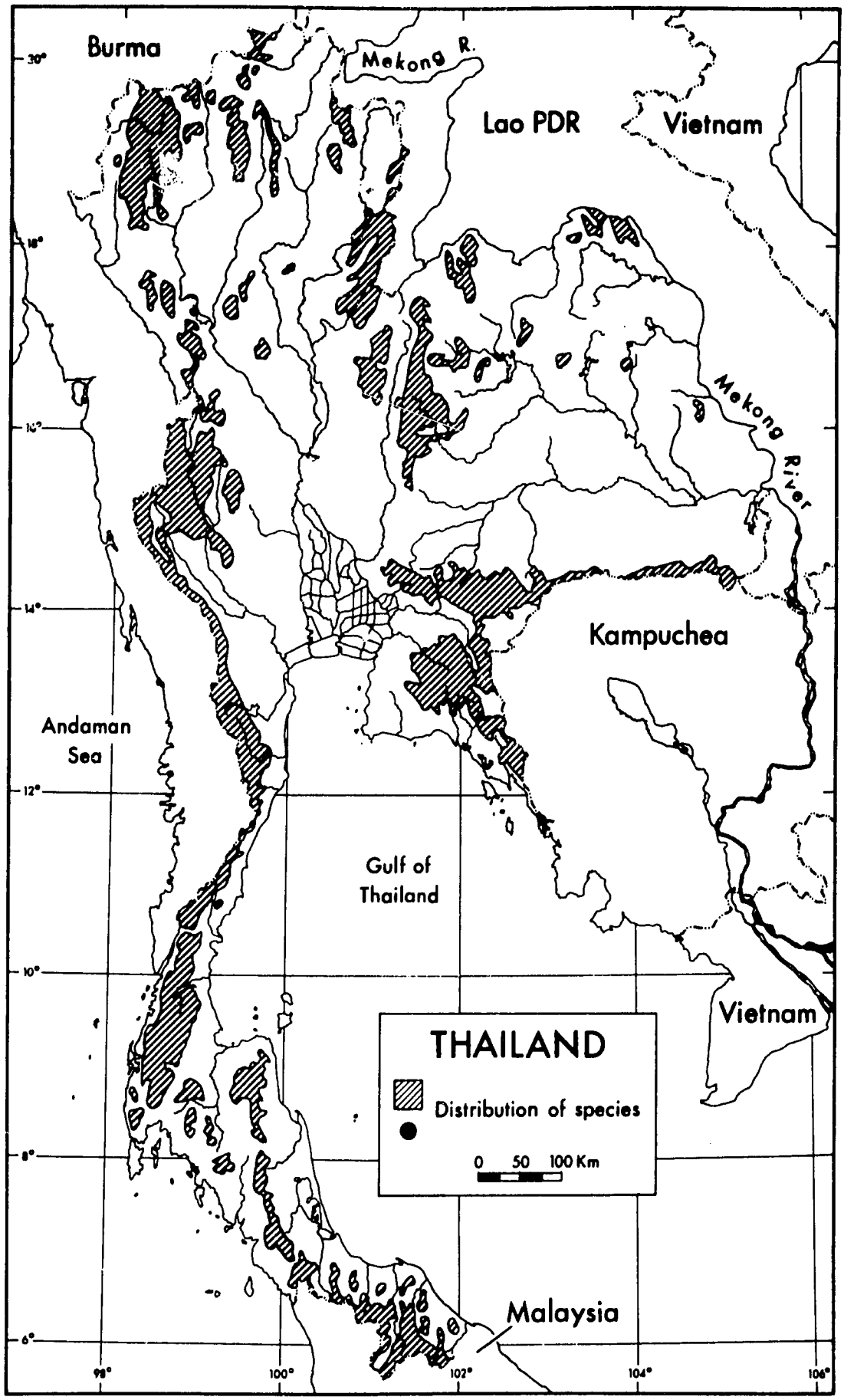
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch is usually 2 eggs, sometimes 1, and rarely 3. Incubation is said to last about 31 days. It breeds from January to April in Burma. Juveniles were found on 18 July at Doi Mon Khawm Long in Thailand. McClure (1974a) saw breeding behavior in January and July in Khao Yai National Park, and he inferred that the breeding season is primarily from January to May from the animals he observed for sale in the Sunday Market. Frith and Douglas (1978) obtained a nestling at the Sunday Market on 10 April (Deignan 1945, Smythies 1953, Ali and Ripley 1970).

Key Behaviors: This species has been reported to mate for life. In the nesting season the birds are much quieter than usual. They select nest trees far from the paths of man and often use the same tree year after year if unmolested. In a variation from the usual hornbill pattern, the female escapes from the nest about two weeks after hatching, recloses the nest, and forages for the young with the help of other birds. From August to January the family groups coalesce into larger flocks that roost communally at night. The roosts are made in the tops of several tall, adjacent, thinly foliaged trees. The criteria for roost selection are unclear -- they may choose trees near forest edge or deep in the forest. Within these communal roosts individuals apparently have territories. These groups range in size from a few pairs up to 16 birds. Rarely groups of several hundred have been reported. In the morning, before leaving to forage, there is much vocalization and intraspecific interaction. Although the home ranges of these flocks are unknown, they are thought to cover great distances in their daily searches for food and may use regular foraging beats (Deignan 1945, Wildash 1968, Ali and Ripley 1970, McClure 1970, Holmes 1973, McClure 1974a, Medway and Wells 1976).

Conservation Measures Taken: Thai law (WARPA 1972) protects this species from hunting and export. They have been reported to occur in many proposed and existing protected areas in Thailand, including Doi Suthep-Pui Non-Hunting Area, Doi Chiang Dao Wildlife Sanctuary, Doi Inthanon National Park, Khao Luang National Park, and Tarutao Marine National Park. The presence of healthy populations in Khao Yai National Park demonstrates the value of such reserves to forest dwelling species (Riley 1938, Deignan 1945, Dickinson 1964, McClure 1974a, Pauley 1977a, 1977b). This species has been kept in captivity in Thailand and in many of the world's zoos, and it has bred in captivity (Choy 1980).

Conservation Measures Proposed: Great hornbill populations in protected areas should be censused and managed with their requirements for forest cover, nesting trees, and communal night roosts borne in mind. Hunting, sale, and export regulations should be enforced.



Buceros bicornis

Helmeted hornbill

Rhinoplax vigil (Forster 1781)

Aves, Coraciiformes, Bucerotidae

Status: Endangered.
USFWS (1980a): Endangered.
MAB (1979): Endangered.
CITES (1979): Appendix I.
IUCN (1979): Threatened.
IUCN Red Data Book (1979): Indeterminate.
WARPA (1972): Rare.

Population Size and Trend: Although it may have been common in appropriate habitat in southern Thailand as late as the 1960's, it is now rare in Thailand. There are no estimates of total numbers (Lekagul and Cronin 1974, B. King personal communication).

Distribution and History of Distribution: This striking bird is known from Tenasserim in extreme southern Burma, from southern Thailand, Malaya, Sumatra, and Borneo (King and Dickinson 1975). In February of 1974 Holmes and Wells (1975) heard this species at Khlong Nakha Reserve in Changwat Ranong. King (personal communication) saw one or two in Changwat Nakhon Si Thammarat.

Geographical Status: The Thai population is peripheral, lying near the northern limits of the species' distribution.

Habitat Requirements and Habitat Trend: Rhinoplax prefers the dense, tall, mature evergreen forests from the lowlands to about 1500 m. Such forests are being destroyed at an accelerating rate in Southeast Asia (Gibson-Hill 1949, Harrisson 1951, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976, IUCN Red Data Book 1979).

Vulnerability of Species and Habitat: The tail feathers and casque "ivory" of this bird are actively sought. Its raucous vocalizations and large size attract human predators. The flesh is said to have a superior flavor (Harrisson 1951, King and Dickinson 1975, Medway and Wells 1976).

Causes of Threat: Hunting and deforestation threaten this bird. In Borneo the male is blowgunned outside the nest and the tree is cut down to capture the female and young (Harrisson 1951). The nearly complete forest cover of southern Thailand has declined to 42 percent in 1961, 39 percent in 1965, 25 percent in 1972, and 24 percent in 1978 (Myers 1980).

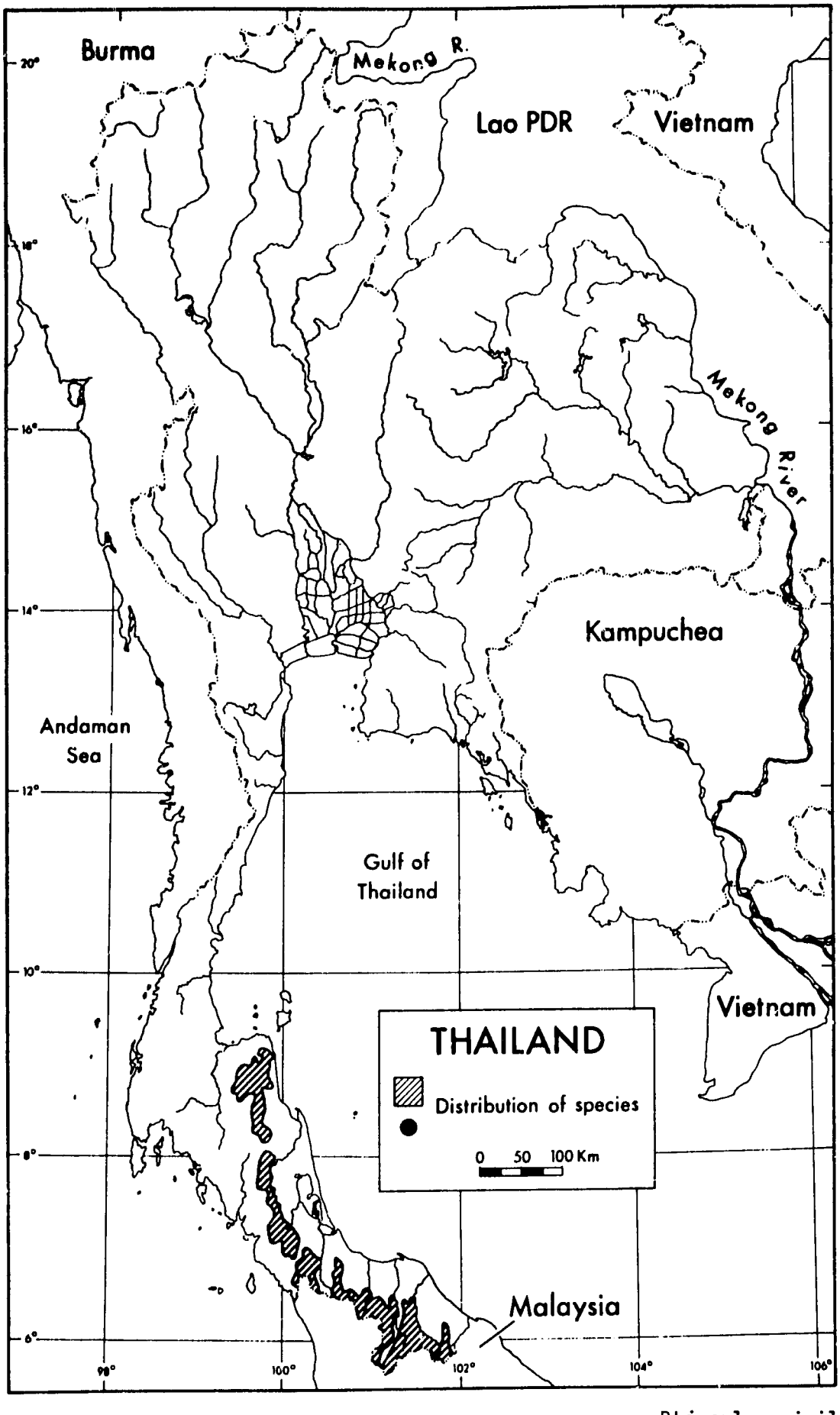
Responses to Habitat Modification: Unknown.

Demographic Parameters: Unknown.

Key Behaviors: Unlike most hornbills this form is not gregarious. Single animals, pairs, and small groups are seen. Its habit of foraging high in the canopy undoubtedly relieves some human predation. Its specific epithet, vigil, is well deserved -- it is very shy and avoids man (Harrisson 1951, Smythies 1953, Glenister 1955, Medway and Wells 1976).

Conservation Measures Taken: Some essential habitat is protected in preserves in the far south. Thai law (WARPA 1972) prohibits the hunting and export of helmeted hornbills without special permission.

Conservation Measures Proposed: A total ban on hunting this hornbill should be considered to allow populations to recover. Protection of the birds inhabiting reserved areas should be maintained. In areas where breeding populations still exist, deforestation should be halted and dead standing timber should not be removed.



Rhinoplax vigil

Great slaty woodpecker

Mulleripicus pulverulentus (Temminck 1826)

Aves, Piciformes, Picidae

Status: Threatened.

Population Size and Trend: Although reported as being common by some writers in this century (Glenister 1955, for example) Lekagul and Cronin (1974) classified this form as an uncommon resident. In some parts of its range it is still locally common (Smith 1977).

Distribution and History of Distribution: This large woodpecker is known from several locations in northern India, Nepal, Sikkim, Bhutan, southwestern China, Bangladesh, Burma, throughout Southeast Asia (except northern Annam, Tonkin, Hong Kong, and, in Thailand, the central valley of the Chao Phraya and much of the northeastern Khorat Plateau), south through Malaya to Singapore, the Greater Sunda Islands,and Palawan (Ali and Ripley 1970, Lekagul and Cronin 1974, King and Dickinson 1975, Medway and Wells 1976).

Geographical Status: The Thai populations are central to the species' overall range.

Habitat Requirements and Habitat Trend: Great slaty woopeckers have been reported from a wide variety of habitats from sea level through the hills to 2000 m. Among the habitats reported are tall mangrove forest, swamp forest, teak, moist deciduous, semi-evergreen, and mature evergreen. forest. It is frequently seen along forest edges and overgrown clearings. It feeds on insects. The preferred foods are the larvae and pupae of wood-boring beetles, such as Haplocerambyx, but other insects, including ants and termites, are also eaten (Deignan 1945, Smythies 1953, Ali and Ripley 1970, Lekagul and Cronin 1974, Medway and Wells 1976).

Vulnerability of Species and Habitat: This is the largest woodpecker in Thailand. They are said to be not unduly shy. Their large size, noisy flight, continual vocalizations, and gregarious habits make them quite noticeable to man (Deignan 1945, Smythies 1953, Lekagul and Cronin 1974, McClure 1974a).

Causes of Threat: Overhunting and deforestation threaten this species.

Responses to Habitat Modification: This species tolerates and may even benefit from disruption of continuous forest habitat. This "edge effect" is a well-known phenomenon in many species of wildlife. However, extensive deforestation leaves no habitat for woodpeckers.

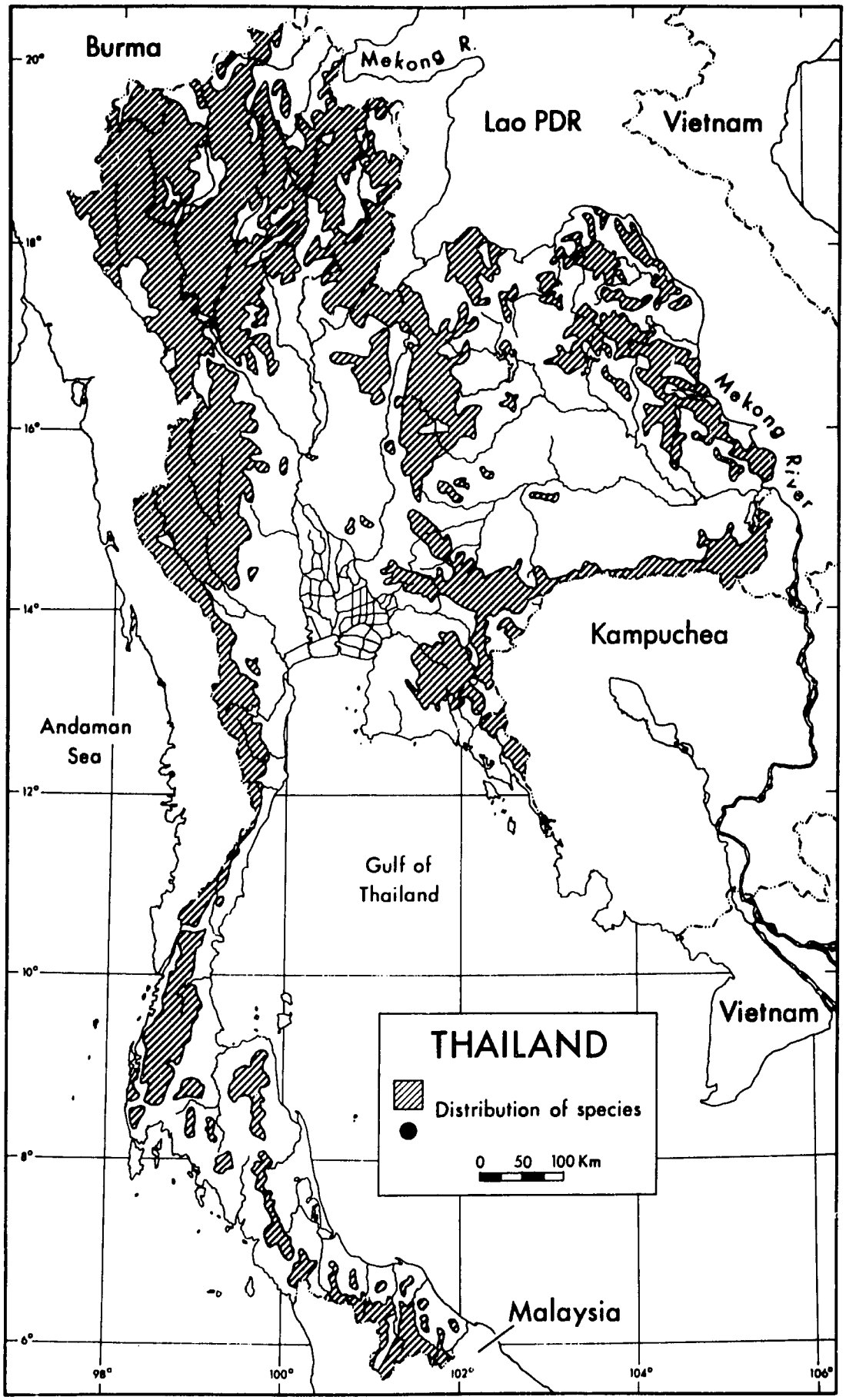
Demographic Characteristics: The normal clutch is 2-4 eggs. Nesting has been reported in March-May in India, April in Burma, and July-August in the Malay Peninsula (Smythies 1953, Ali and Ripley 1970, Medway and Wells 1976).

Key Behaviors: This bird is usually seen in pairs, family groups, and flocks up to about 10 birds. Flocks fly in a sprawling follow-the-leader fashion and can cover great distances over open ground. While foraging, the flock spreads out over several neighboring trees but maintains vocal

communication all the while. There have been reports of birds maintaining territories in Khao Yai National Park. Nest holes are 25 m or more up large, often dead or dying trees. Dipterocarps are frequently used. Both sexes help to excavate the hole, incubate the eggs, and feed the young (Ali and Ripley 1970, Lekagul and Cronin 1974, McClure 1974a, Pfanner 1974, King and Dickinson 1975).

Conservation Measures Taken: Because of its wide range in Thailand and its use of many habitats, many populations undoubtedly occur in protected areas. It has been recorded in the literature to occur in what is now Tarutao Marine National Park, Khao Luang National Park, and the Doi Suthep-Pui Nonhunting Area (Riley 1938, Deignan 1945, Medway and Wells 1976). More recently, the bird has been studied in Khao Yai National Park (McClure 1974a, Pfanner 1974). There are no Thai laws that specifically protect the species.

Conservation Measures Proposed: The senescent giant trees these birds require for nesting should not be removed. In educational and conservation programs the value of these animals in controlling forest pest insects should be stressed. The degree to which human modification of native habitats affects these large woodpeckers needs to be studied. Hunting should be controlled.



Mulleripicus pulverulentus
and Drycopus javensis

White-bellied woodpecker

Dryocopus javensis (Horsfield 1821)

Aves, Piciformes, Picidae

Status: Threatened.

Population Size and Trend: This woodpecker varies locally from common to rare, depending on the availability of suitable habitat (Riley 1938, Smythies 1953, Glenister 1955, Ali and Ripley 1970). A declining trend is presumed because of habitat loss.

Distribution and History of Distribution: The white-bellied woodpecker occurs from India, China, Korea, and Japan, south through Southeast Asia to Sumatra, Java, Borneo, Bali, and the Philippines. It occurs all over Thailand in suitable habitat (Medway and Wells 1976, Deignan 1963). Its range has been reduced and fragmented by deforestation in India (Ali and Ripley 1970) and elsewhere.

Geographical Status: Thailand is central in the species' range.

Habitat Requirements and Habitat Trend: This species is most common in mature forest up to 600-1400 m elevation. It also uses forest edge, secondary forest, and mature plantations. Nests are excavated in dead tree trunks about 8-16 m above the ground. Much habitat has been destroyed by deforestation (Deignan 1945, Ali and Ripley 1970, Medway and Wells 1976).

Vulnerability of Species and Habitat: The habitat of this species is highly vulnerable to deforestation.

Causes of Threat: Deforestation threatens this species.

Responses to Habitat Modification: This species is "very sensitive to deforestation and disturbance by humans, soon forsaking localities where lumbering is in progress or the forest has been felled" (Ali and Ripley 1970).

Demographic Characteristics: The clutch usually contains 2 or sometimes 3-4 eggs. Reproduction occurs in January to March in India (Ali and Ripley 1970).

Key Behaviors: Both sexes participate in nest excavation and feeding the young. Foraging usually is done in pairs or family groups, in which the individuals keep in contact by calling (Ali and Ripley 1970).

Conservation Measures Taken: Many populations undoubtedly occur in protected areas in Thailand. Records exist for Doi Suthep-Pui Nonhunting Area (Deignan 1945) and Khao Yai National Park (McClure 1974a).

Conservation Measures Proposed: Preserving tracts of mature forest is the key to conservation of this species. Dead trees should be left standing, because their removal destroys nesting and foraging habitat of woodpeckers.

Gurney's pitta

Pitta gurneyi Hume 1875

Aves, Passeriformes, Pittidae

Status: Threatened.
IUCN Red Data Book (1979): Indeterminate.

Population Size and Trend: This bird was considered to be common over its range in Thailand 40-50 years ago (Riley 1938, Chasen 1939). It is now scarce over much of its range in Thailand. Its current status in Burma is unknown (IUCN Red Data Book 1979). There are no estimates of its total numbers.

Distribution and History of Distribution: Gurney's pitta is endemic to southern Tenasserim in Burma and parts of adjacent peninsular Thailand. In Thailand it ranges from Changwat Prachuap Khiri Khan south to Trang (Deignan 1963, King and Dickinson 1975).

Geographical Status: It has been suggested that the Burmese population is migratory and breeds in Thailand, but this has not been established. The Thai population is believed to be sedentary (Gibson-Hill 1949, Smythies 1953).

Habitat Requirements and Habitat Trend: This *Pitta* dwells on the ground in dense primary evergreen forest in the lowlands below 900 m, especially in areas where there is little or no undergrowth. The lowland forest over much of its range has been cleared (Rutgers 1968, Smythies 1953, Lekagul and Cronin 1974, King and Dickinson 1975, IUCN Red Data Book 1979).

Vulnerability of Species and Habitat: Pittas are colorful birds and people find them attractive. There is an active trade in live animals. The lowland forests they require are among the first to be cleared.

Causes of Threat: Overhunting and deforestation threaten this species. During the study period 31 March to 6 June 1975 almost 80 *Pitta* (all species combined) were known to have been exported through Bangkok's Don Muang Airport (Duplaix and King 1975). Annual exports of pittas from Thailand from 1967 to 1971 were 75, 71, 327, 542, and 74 (Royal Forestry Department 1972).

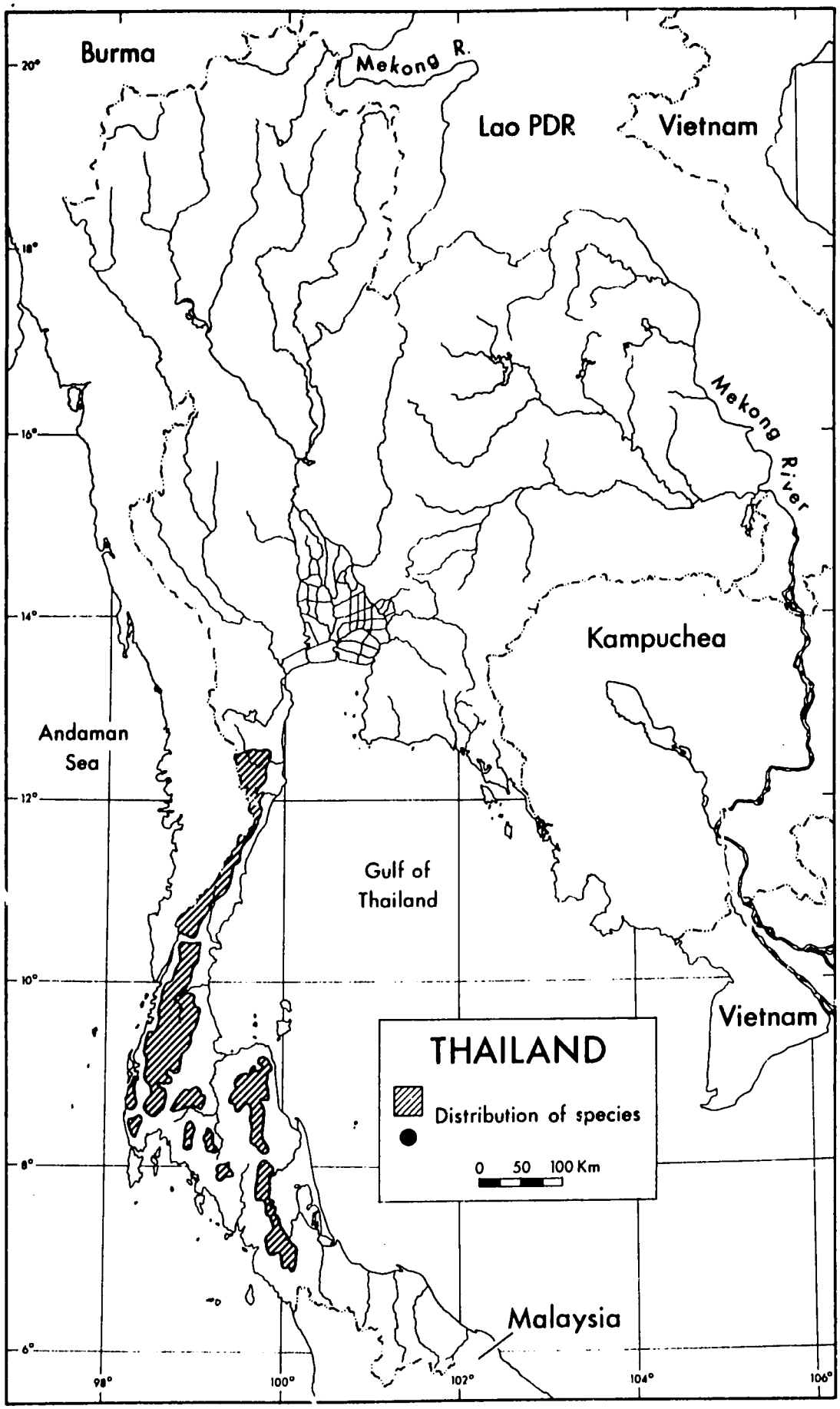
Responses to Habitat Modification: The disappearance of this bird over much of its Thai range is probably due to its intolerance of deforestation.

Demographic Characteristics: The normal clutch size is 4 eggs. A nest with eggs was found in Changwat Nakhon Si Thammarat on 9 October. A nestling was found in Changwat Krabi in August. Specimens dissected in Burma from April, May, and June were nonreproductive (Riley 1938, Smythies 1953, Medway and Wells 1976).

Key Behaviors: These shy and retiring birds are notoriously difficult to find and study. They are usually found singly or in paris and vocalize to each other in the morning and evening. Gurney's pitta hops along the ground in search of food. Although they prefer areas with little undergrowth, when danger threatens the birds run for the nearest canebrake or other dense cover (Smythies 1953, Rutgers 1968, B. King personal communication).

Conservation Measures Taken: Duplaix and King (1975) call this bird a Category I protected bird. This bird may occur in some of the Wildlife Sanctuaries and National Parks in the south.

Conservation Measures Proposed: In biological surveys of Khao Luang National Park, Khlong Saeng Wildlife Sanctuary, Khlong Nakha Wildlife Sanctuary, and the proposed Khlong Phraya Wildlife Sanctuary, this species should be sought. In areas where populations survive, forestry management officials should consider the needs of this forest floor dweller. In timber harvest and controlled burns, open areas with patches of brush or cut slash for cover should be maintained under the lowland evergreen forest canopy. The life history and habits of this and other pittas need to be studied more thoroughly. Cooperative banding studies with the Union of Burma should be considered to learn the true movements of the species to aid in formulating sound management plans. Hunting and export should be monitored and controlled.



Pitta gurneyi

White-eyed river martin

Pseudochelidon sirintarae Kitti 1968

Aves, Passeriformes, Hirundinidae

Status: Endangered.
CITES (1979): Appendix II.
IUCN (1979): Threatened.
IUCN Red Data Book (1979): Indeterminate.

Population Size and Trend: Population size is unknown but small (Lekagul and Cronin 1974, King and Kanwanich 1978, IUCN Red Data Book 1979).

Distribution and History of Distribution: The species is known only from Bung Boraphet in Changwat Nakhorn Sawan in central Thailand (Kitti 1968, 1969; King and Kanwanich 1978). All records are from November to March. The summer range and breeding grounds are unknown.

This distinctive species was first captured in January 1968 by professional bird hunters hired to net swallows (Hirundo rustica) for the Migratory Animals Pathological Survey (MAPS). In January and February of 1968 a total of nine specimens were procured from hunters. These included subadult males and adult females, but mostly juveniles. Kitti (1968) subsequently described the species and named it in honor of H.R.H. Princess Sirindhorn Thepratanasuda in recognition of her keen interest in natural history (Lekagul and Cronin 1974). Kitti searched unsuccessfully for river martins during the first two weeks of March of that year. He secured one specimen in November (Kitti 1968, 1969; King and Kanwanich 1978).

Between 1968 and 1977 several white-eyed river martins showed up in local markets in January and February (King and Kanwanich 1978). Two were found in 1972 (IUCN Red Data Book 1979). One individual was reported in 1978 (IUCN 1979).

The only close living relative of P. sirintarae is P. eurystomina of the Zaire (Congo) River in west-central Africa. Together the two comprise the martin subfamily Pseudochelidoninae. The habit of the latter species of breeding on sand flats, sand islands, and sandbars (Chapin 1954) led Kitti to search the rivers north of Bung Boraphet for breeding river martins in the summer of 1969. Kitti searched from 21 May to 27 June along the Mae Nam Wang, Yom, and Nan but found no Pseudochelidon (Kitti 1969).

From 31 January to 4 February 1977, King and Kanwanich (1978) made the first observations by professional ornithologists of wild P. sirintarae. Six sightings and two suspected sightings were made. All were thought to be adults. The birds were seen flying low and skimming the water in late afternoon and early evening. David Ogle of LaSalle Chotiravi College is currently seeking P. sirintarae in Thailand (King, personal communication, 1980).

Geographical Status: Existing data indicate that the white-eyed river martin is an endemic winter resident (King and Dickinson 1975), migrating to an unknown breeding locality, possibly in the north. Its separation from its African congener by 10,000 km suggests that the Thai population is relictual in nature.

Habitat Requirements and Habitat Trend: The birds roost among the extensive reed beds of the large, shallow, freshwater Bung Boraphet. During the time the river martins are present, thousands of barn swallows (H. rustica) and weavers (Ploceus sp) and hundreds of yellow-breasted buntings (Emberiza aureola) also roost in the reeds (King and Kanwanich 1978). Observations suggest that the winter foraging habitat is over or near the lake. Encroachment by rice cultivation has reduced the marsh from an original 25,000 ha to 5,000 ha (IUCN 1979). The summer habitat is unknown, and diet has not been documented.

Vulnerability of Species and Habitat: Because this species uses wetland habitat, it is vulnerable to changes in both the reservoir and the connected upland watershed. Threatening changes would include deforestation of the watershed, increased runoff of agricultural pollution, eutrophication of the water, alteration of the hydrological cycle of the marsh, or continued conversion of marshland to agriculture.

Causes of Threat: Bird hunters usually sell their catch to local markets where they are sold for food or for the religious practice of releasing captive birds to acquire merit (King and Kanwanich 1978). These authors believed that continued netting by bird hunters could extirpate the species. Reduction of the marsh to 20 percent of its former size by rice cultivation is a serious threat, probably compounded by undocumented changes in the hydrologic forces that maintain the ecosystem. Human control of the ecosystem by establishing a reservoir has undoubtedly modified important processes regulating the river martin habitat. Such changes have not caused extirpation, but their long-term implications are unknown.

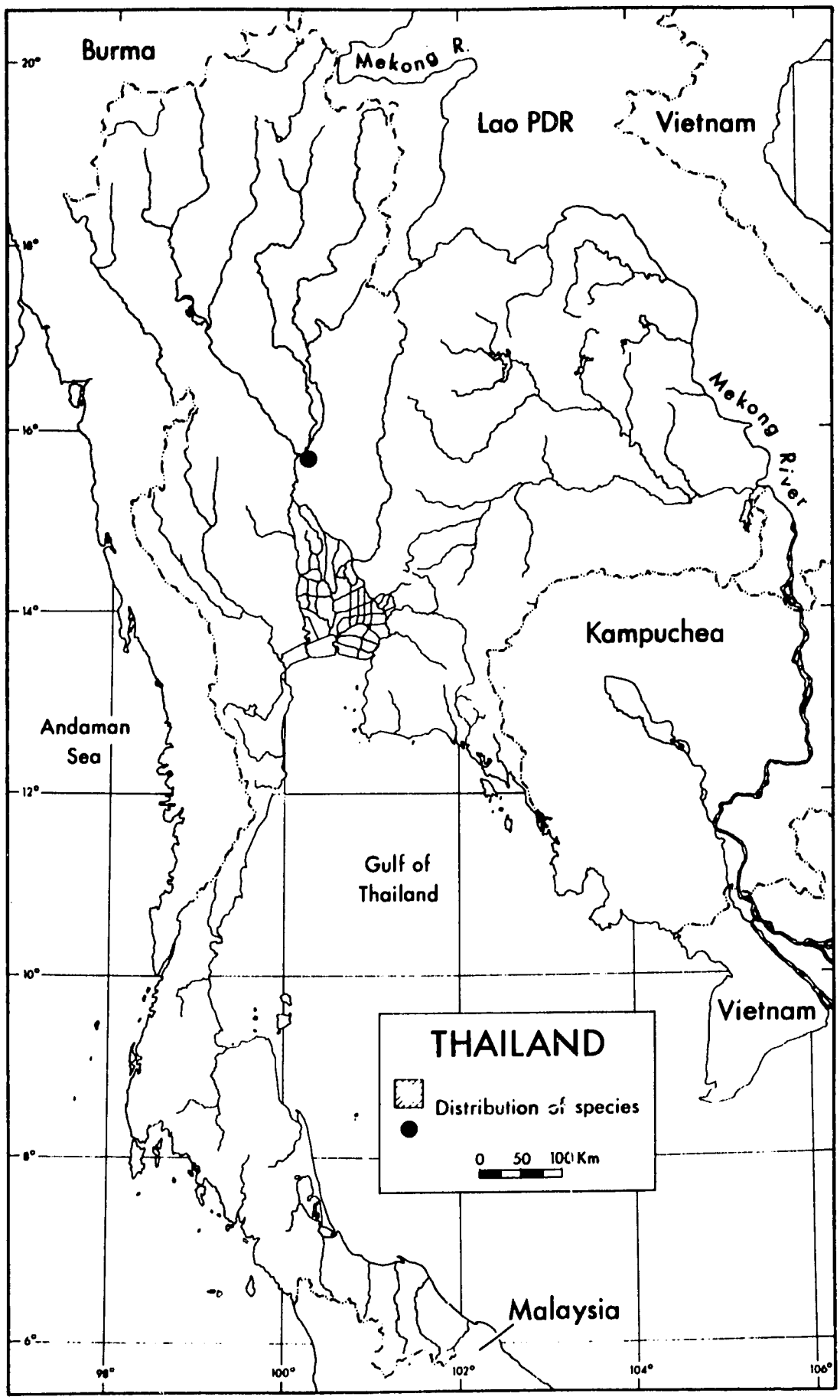
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: The river martin apparently migrates between summer and winter ranges.

Conservation Measures Taken: Much essential habitat is included in the Bung Boraphet Non-hunting Area.

Conservation Measures Proposed: The elucidation of the summer range and breeding grounds are of paramount importance to the conservation of the species. The initiation of cooperative banding studies with Burma, Laos, China, and other countries should be considered. Bird trapping at Bung Boraphet should be reduced or, ideally, eliminated altogether (King and Kanwanich 1978). Designation of Bung Boraphet as a Non-hunting Area appears to be ineffective in preventing collecting of river martins, and more rigorous protection is needed. It is an important wetland for waterfowl and historically supported the endangered Siamese crocodile (*Crocodylus siamensis*). It is the largest freshwater marsh in Thailand. Encroachment by rice cultivation should be halted. King and Kanwanich (1978) suggested that studies be conducted to determine the feasibility of allowing lotus culture and fishing to continue.



Pseudochelidon sirintarae

Rail-babbler

Eupetes macrocerus Temminck 1831

Aves, Passeriformes, Muscicapidae

Status: Threatened.

Population Size and Trend: Unknown, but surely declining.

Distribution and History of Distribution: The rail-babbler occurs in peninsular Thailand from Surat Thani and Trang south to peninsular Malaysia, Sumatra, the North Natunas, and Borneo (Riley 1938, Delacour 1947, Deignan 1963). Its range has been greatly reduced and fragmented by deforestation.

Geographical Status: The rail-babbler reaches its northern limit in southern Thailand.

Habitat Requirements and Habitat Trend: This species inhabits lowland forests up to 800 m elevation. Only primary or recovering secondary forest are known to be occupied (Riley 1938, Delacour 1947, Holmes 1973). Very little of this habitat remains in southern Thailand. The diet is insects found on the forest floor.

Vulnerability of Species and Habitat: Its habitat is highly vulnerable to deforestation.

Causes of Threat: Deforestation threatens this species.

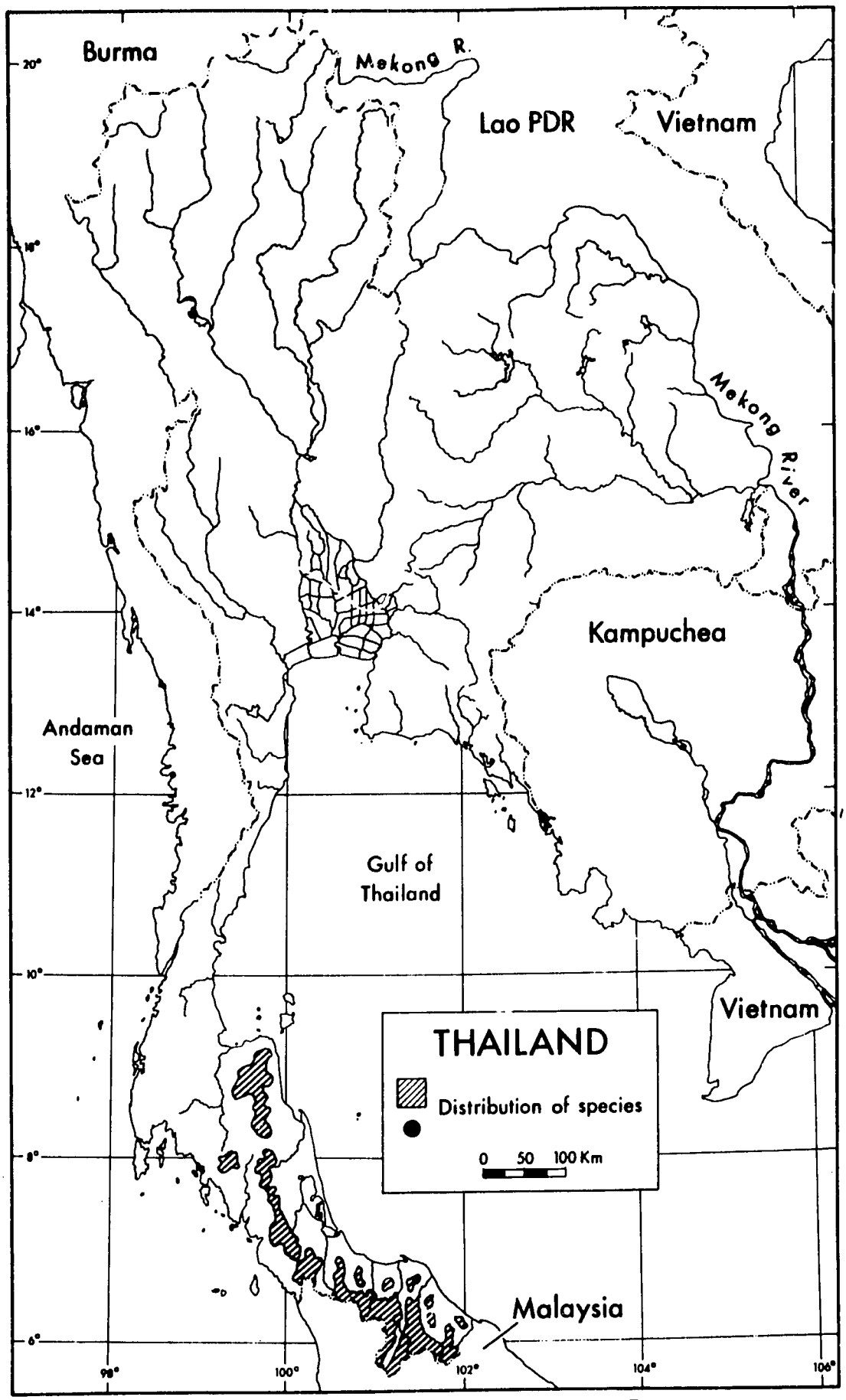
Responses to Habitat Modification: Unknown.

Demographic Characteristics: Unknown.

Key Behaviors: Unknown.

Conservation Measures Taken: None.

Conservation Measures Proposed: Existing national parks and wildlife sanctuaries should be surveyed by listening for the distinctive call (Holmes 1973) to learn if occupied habitat is protected. Proposed sanctuaries also should be examined to see if the number of protected populations can be increased.



Eupetes macrocerus

Large grass warbler

Graminicola bengalensis Jerdon 1863

Aves, Passeriformes, Muscicapidae

Status: Extirpated from Thailand.

Population Size and Trend: The large grass warbler has not been recorded from Thailand since 1923 (Deignan 1963). Elsewhere it persists and is locally common (Ali and Ripley 1973).

Distribution and History of Distribution: In Thailand this species occupied the southern portion of the central plains (Deignan 1963). Records also exist from Kwangtung Province, China, and Hainan (La Touche 1931-34, Ali and Ripley 1973). The best documented range is from the western Nepal terai, east through northern Bengal and the floodplains of Bangladesh to the Ganges (Ali and Ripley 1973). Other populations are known at low elevations in Tenasserim Province, Burma, and Tonkin (presumably the Hong or Red River basin of northern Vietnam, King and Dickinson 1975).

Geographical Status: The Thailand portion of the species' range presumably was a disjunct but sizeable population occupying the lower floodplain of the Mae Nam Chao Phraya and its tributaries.

Habitat Requirements and Habitat Trend: The large grass warbler lives in tall grass and reeds. Nests are placed in dense grass or reeds over deep water during the monsoon. This suggests an expanse of marsh, everglades, or wet savanna as the original vegetation of the lower Chao Phraya basin.

Vulnerability of Species and Habitat: The entire habitat in Thailand has been drained by canals and converted to rice paddies, orchards, and human population centers.

Causes of Threat: Habitat loss may threaten the large grass warbler elsewhere in its range.

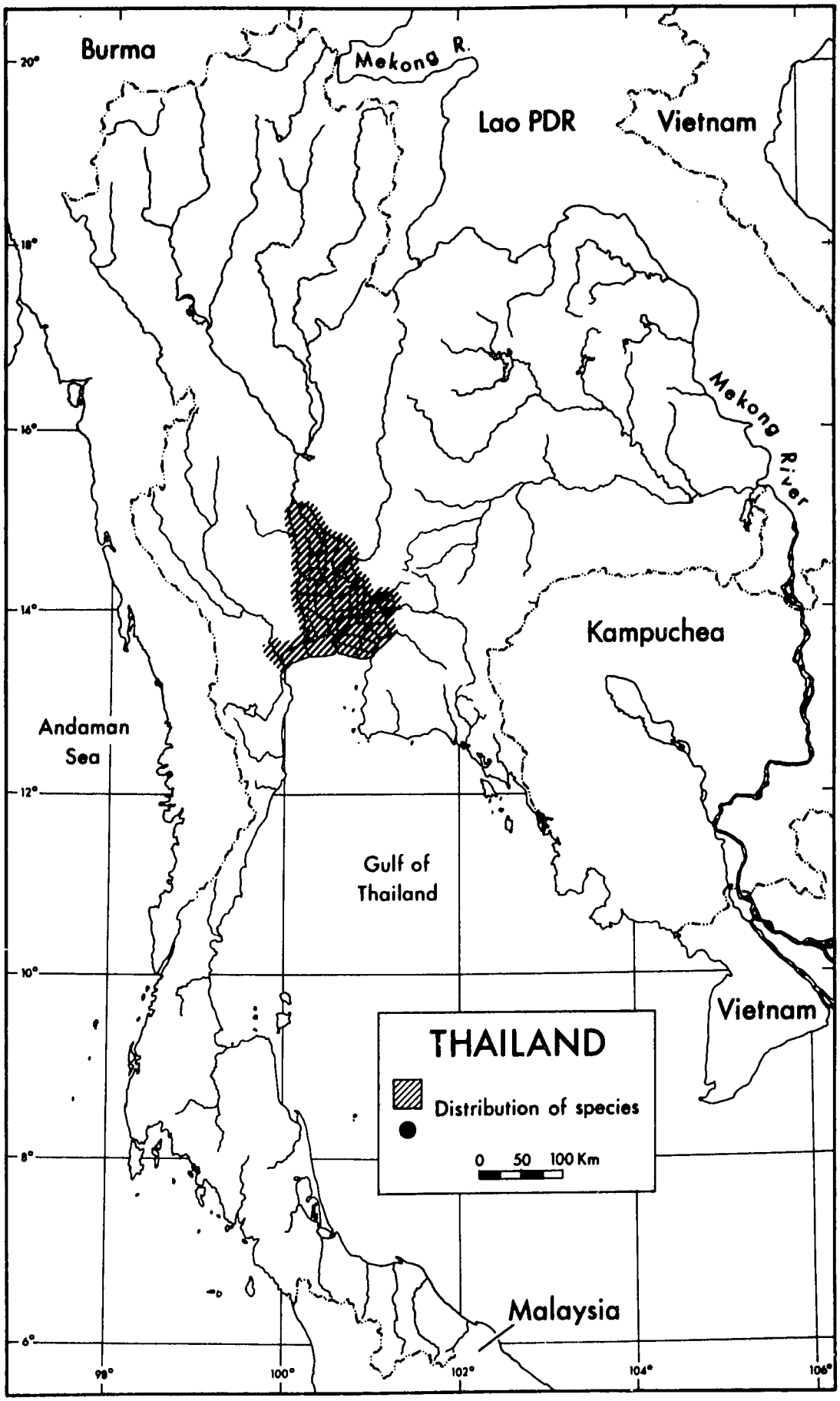
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The number of eggs per clutch is "apparently 4" (Ali and Ripley 1973).

Key Behaviors: Breeding occurs in July and August. Observing this species is facilitated by their territorial display of soaring above the marsh vegetation to sing (Ali and Ripley 1973).

Conservation Measures Taken: None.

Conservation Measures Proposed: None for Thailand. Habitat requirements and effective management of the large grass warbler parallel those of the dusky and Cape Sable seaside sparrows in the United States, for which disruption of regional flood-controlled marshland is disastrous.



presumed former range of Graminicola bengalensis

Mangrove Whistler

Pachycephala cinerea

Aves, Passeriformes, Muscicapidae

Status: Threatened.

Population Status and Trend: Common but probably declining.

Distribution and History of Distribution: The mangrove whistler occurs along the coasts of eastern India, Bangladesh, Burma, Thailand, southern Vietnam, the mainland and islands of Malaysia south to Singapore, the Philippines, and the Lesser Sunda Islands (Ali and Ripley 1972, Medway and Wells 1976).

Habitat Requirements and Habitat Trend: This species inhabits coastal forests of mangrove and casuarina, and locally plantations, second growth, and wooded gardens up to 40 km inland (Glenister 1955, Medway and Wells 1976). Nests are built in small trees 1-4 m above the ground. The diet is insects captured in the air and on vegetation (Ali and Ripley 1972). Mangrove and casuarina forest are heavily harvested for charcoal, and few or no primary stands remain in Thailand.

Vulnerability of Species and Habitat: Coastal forest is highly vulnerable to deforestation for charcoal production and coastal development including housing, mines, and shrimp farms.

Causes of Threat: The mangrove whistler is threatened by habitat loss.

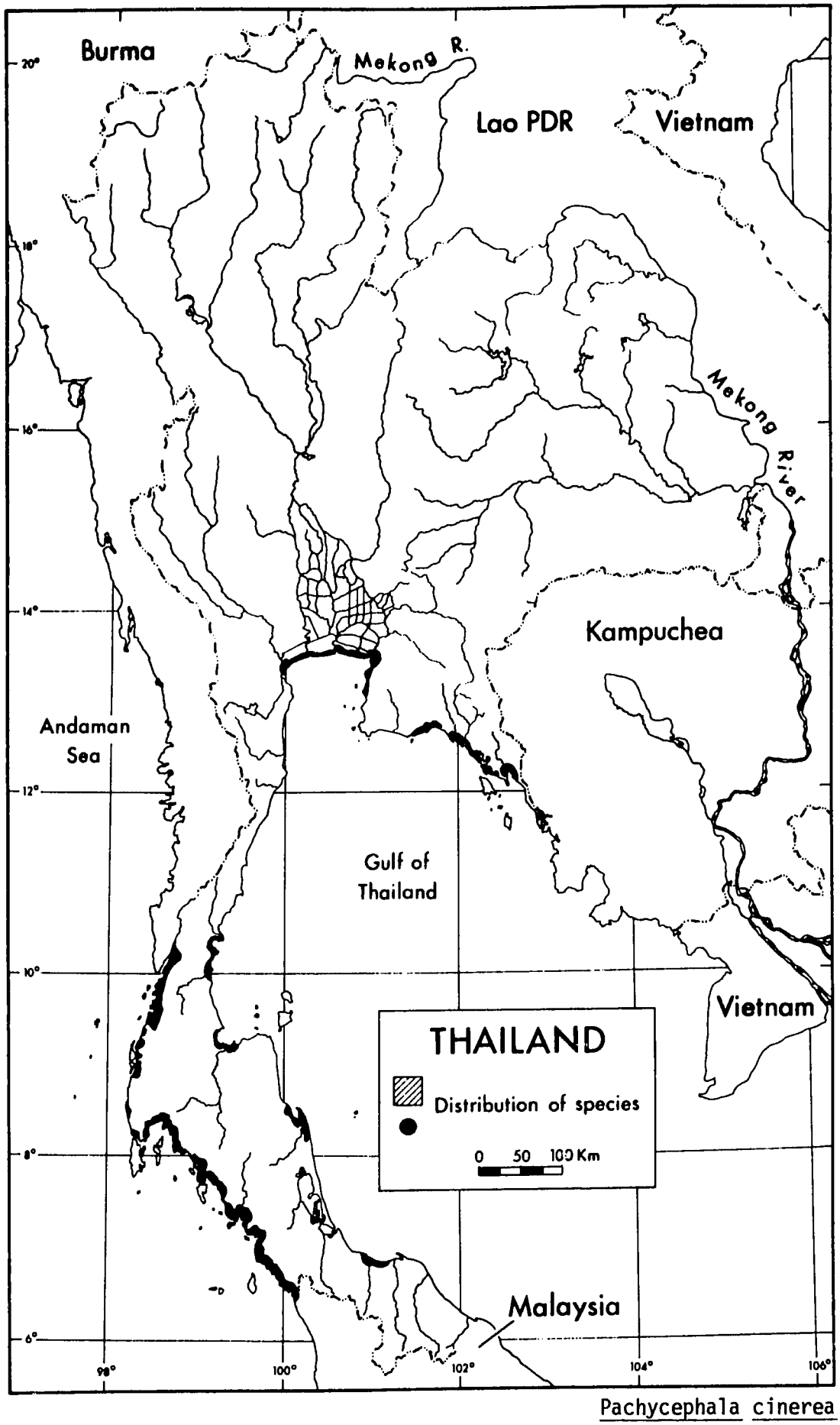
Responses to Habitat Modification: Unknown.

Demographic Characteristics: The clutch contains 2 eggs. The breeding season extends from April to July in India and March to June in peninsular Malaysia (Ali and Ripley 1972, Medway and Wells 1976). Banded individuals have been recaptured up to 68 months later (McClure 1974b).

Key Behaviors: This species is not migratory (McClure 1974b).

Conservation Measures Taken: To counter the unsustainable, high rate of harvest of mangroves for charcoal, the Royal Forestry Department has instituted a 30-year strip harvest regulation, designed to maintain a sustained yield of charcoal and retain the valuable ecosystem functions of coastal forests.

Conservation Measures Proposed: The strip rotation regulation should be enforced rigorously. Mangrove habitat is economically important because it provides protection from storms to inland developments and biological productivity that supports the young of many commercially valuable marine species of fish. The response of mangrove whistlers to habitat modification should be determined. With that knowledge, strip-censuses of species may be useful as an indicator of the age of mangrove forests.



Pachycephala cinerea