A MANAGEMENT AND CONSERVATION STRATEGY FOR THE TAWU MOUNTAION NATURE RESERVE, TAIWAN,R.O.C

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Summary

The 470 km^2 area that comprises the Tawu Mountain Nature Reserve is one of the few large pieces of low to middle elevation pristine forest remaining on the island of Taiwan. Scientific research, conducted within the current boundaries of the reserve, has indicated that the diverse array of habitats, from lowland subtropical rainforest to high elevation coniferous evergreen forest, contain some of the most abundant wildlife populations left on Taiwan. Among these populations is a biological diversity that includes many endemic species and subspecies, such as the Formosan clouded leopard, a cat thought to be virtually extinct on Taiwan, but which may still exist in small numbers within the reserve.

In addition to its rich floral and faunal communities, the Tawu Mountain Nature Reserve encompasses five major watersheds. These watersheds, drained by the Tanan, Chipen, Tamali, Chinlun and Tachu Rivers, are a major source of water for both human and agricultural use in this part of Taiwan. Furthermore, as part of the southernmost portion of the Central Mountain Range, this large and diverse protected forest area helps to prevent many of the effects of environmental degradation occurring elsewhere on the island. For this reason alone, it is in the best interests of Taiwan to conserve and properly manage the integrity of the reserve.

Although the boundaries of the Tawu Mountain Nature Reserve do not encompass any active human settlements, the reserve is presently

impinged upon by activities from the surrounding areas. These activities include mining operations, hunting, and uncontrolled visitation for recreational purposes. Of these activities, hunting is by far the greatest threat to the reserve. The mining operations can be controlled and eventually restricted. Recreational use of the reserve can be managed and potentially developed further for the benefits of the public. However, the illegal hunting must be stopped at all costs because it is occurring at a level that threatens to severely decimate and eventually wipe out much of the wildlife within the reserve.

Current hunting practices within the Tawu Mountain Nature Reserve are carried out primarily by aboriginal people and are not done in any traditional manner. Most of the hunting, utilizing jaw traps and snares, is indiscriminate, inhumane and wasteful. Surveys indicate that captured wildlife are usually sold for personal profit, and that very few hunters rely on hunting as their main income or for their main source of protein. Furthermore, nearly all hunters surveyed stated that they have seen an obvious decline in the abundance of most wildlife species in recent years.

The objective of this management strategy is to set criteria that will help in protecting the Tawu Mountain Nature Reserve to the fullest extent possible, while allowing it to be of positive benefit to the people of Taiwan. The recommendations presented here strive towards three major objectives: a) the maintenance of biological diversity, b) maximizing protection of the watersheds, and c) the maintenance of

ecosystem stability. In order to achieve these broad objectives, there should be no further environmental degradation of the reserve. More specifically, this calls for: 1) prohibiting any subdivision of the reserve, as would be caused by construction of roads into the reserve, 2) prohibiting any activity that contributes to habitat degradation such as mining operations and hunting, and 3) maximizing the protection of the reserve by frequent patrols, good management procedures, and efforts to increase the size of the reserve and its buffer zone areas.

Through the protection and proper management of the Tawu Mountain Nature Reserve, Taiwan will not only be preserving one of its last pieces of rich natural forest land, it will be saving part of its natural heritage and helping to preserve an important piece of the global pool of biological resources.

I. Introduction

In 1980, the International Union for the Conservation of Nature and Natural Resources (IUCN) created a World Conservation Strategy in which they put forth three basic goals for regulating natural resource exploitation and environmental degradation worldwide, with particular emphasis on the tropics. These goals include:

a) Maintenance of essential ecological processes and special environmental features;
b) Preservation of genetic diversity through protection of different plant and animal species in various habitats;
c) Assurance of sustainable utilization of natural resources through careful management planning, for the benefit of present and future generations.

The World Conservation Strategy helps to define the broad framework in which countries should plan their future development if they are to be assured of maintaining much of their natural resource base for future generations. Only in recent years have countries started to realize that conservation of natural resources is an essential component of economic growth and stability and must be incorporated into any long term planning. It is now understood by many governments that the protection and conservation of resources in the form of parks, sanctuaries, and reserves, is not a "locking up" of the land that only wealthier nations can afford, but a protective measure that helps assure the future wealth and well-being of a country. Nations that have not conformed to this way of thinking often realize their mistake too late,

when they undergo an economic backlash caused by uncontrolled exploitation of resources.

Today the field of conservation biology is at the forefront of helping governments document and understand the extent of their biological and physical resources, and showing how the proper protection and management of these resources can give long term socio-economic benefits to large numbers of people. In moving towards this goal, there must first be an understanding that the process of simply enacting legislation to create a "protected area" is usually insufficient in the long term. Although this is the crucial first step in most cases, it must be followed by careful and deliberate management of the area. Such management must take into account the biological needs of the flora and fauna, the socio-economic needs of the people within and/or outside of the protected area, and the political framework in which one is operating.

Taiwan is an area which, in the past, has heavily exploited its natural resource base and, until very recently, has virtually ignored the protection of its natural habitats. This has resulted in some major changes in the island's resources, such as the loss of nearly all lowland tropical rainforest habitat; loss of much of the mangrove forests; the extinction of an endemic subspecies of ungulate, the Sika deer; the possible extinction of the island's largest predator, the clouded leopard; and the endangerment of several endemic mammal and bird species such as the Formosan black bear, Hodgson's hawk eagle, Swinhoe's blue pheasant, and the Mikado pheasant. Subsequent socio-economic problems that have followed this environmental degradation include

severe air and water pollution and increasing incidence of drought conditions within the southern region of the island.

The creation of the Tawu Mountain Nature Reserve, Taiwan's largest nature reserve and third largest protected area, is a step in the right direction for Taiwan's future development and well-being. Now, efforts must be made to properly maintain this area in its natural state. The management and conservation strategy presented in this report is an effort to establish criteria for the protection of this very special area. It is hoped that this strategy, which is the first of its kind for a reserve in Taiwan, will not only help to protect the Tawu Mountain Nature Reserve, but will serve as a model for other protected areas on Taiwan and elsewhere.

In 1981, a National Park Department was founded. Between 1984 and 1986, the first 4 national parks were set up: Kenting (1984), Yushan (1985), Yangmingshan (1985), and Taroko (1986). A fifth national park was planned for 1989 on Orchid Island to preserve the cultural heritage of the Yami tribal people. The four national parks comprise 6.6% of Taiwan, and are areas of special ecological and aesthetic importance. In 1988, Tawu Mountain Nature Reserve was established in response to scientific data indicating that this area was one of the few extensive tract of pristine low to middle elevation forest left on the island. The area not only contained a cross section of much of Taiwan's original habitats, but also a wealth of wildlife that was unparalleled in much of the remaining forests on the island. This was a new step forward for Taiwan. The act of preserving a large piece of forest for its diversity and abundance of flora and fauna was not only following the IUCN World Conservation Strategy guidelines and helping to preserve global resources, but it was also an acknowledgement that the protection of Taiwan's natural resources is important for quality of life in the future.

For a more detailed background on the conservation movement in Taiwan from early times up to the present, see Patel and Lin (1988).

III. Tawu Mountain Nature Reserve - Core Area

A. Historical background

During September 1986, a countrywide survey for the Formosan clouded leopard indicated that the forested region in the vicinity of the Tawu Mountains might be one of the last strongholds for this rare and secretive cat (Rabinowitz, 1988). Furthermore, the survey indicated that the Tawu Mountain area was potentially one of the richest wildlife regions left on the island, and supported an earlier study (Severinghaus, 1977) in recommending the region for protection.

Subsequent interest by COA in the richness and potential importance of the Tawu Mountain region led to the creation in 1987 of an eight person Tawu Mountain scientific team with specialties in zoology, botany, anthropology, and geology. This team conducted detailed surveys which led to a preliminary report on the natural resources of the Tawu Mountain area (Wang et al., 1987, 1988). The report supported earlier speculation that the area was indeed rich in both plant and animal life and was crucial for protection of the water resources of the region. Following the surveys, potential boundaries for the reserve and buffer zone areas were delineated and a preliminary report was written (Rabinowitz et. al., 1987). These boundaries took into account the protection and maintenance of the natural floral and faunal communities, current human settlements and land use practices, and the optimal protection for the watersheds and water catchment areas in the region.

With protection efforts spearheaded by Mr. Chin-Chao Koh, former Vice-Chairman of COA, the boundaries delineated by the scientific team officially became the Tawu Mountain Nature Reserve on January 13, 1988 under legislation designated by the Cultural Heritage Preservation Act of Taiwan (Appendix I). This forested region, 1.3% of the island's land surface, became Taiwan's largest nature reserve and third largest protected area, incorporating five watersheds and an abundance of plant and animal life. Two large buffer areas, one to the west of the reserve and a second to the north, were also set up to protect the core reserve area. The creation of the reserve received immediate international acclaim and recognition (Rabinowitz, 1989).

B. Size and location

The Tawu Mountain Nature Reserve is an area of 470 km^2 with the Central Mountain Range as its western boundary. It is located in the southeastern part of Taiwan in Taitung County (Fig. 1) between 22°50' - 22°25' N latitude and 120°43' - 120°57' E longitude. The reserve is under the jurisdiction of the Taitung Forest District Office and is within two forest districts: Taitung District, forest blocks 18-26, 35-40, 42-43, 45-50, and part of blocks 41 and 51 (excluding the mining concessions); and Tawu District, forest blocks 2-10, 12-20, 24-30.

C. Habitat and topography

The reserve area consists of habitats ranging from subtropical in the lowlands to temperate coniferous forests at higher elevations. Over 90% of the reserve consists of natural broad-leaved forests, followed

proportionately by natural mixed broad-leaved-conifers, natural conifers, broad-leaved plantation, and grassland (Fig. 2).

The elevational gradient within the reserve varies between 200 m and 3100 m, with 30% of the forest between 600-1000 m, and 75% of the reserve below 1500 m (Table 1). The mountain slopes vary between approximately 9° and 53°, with over 50% of the reserve with slopes from 25°-32°. Over 90% of the reserve is less than 42° slope (Table 2).

D. Climatic parameters

Temperatures in the Tawu Mountain area vary greatly with elevation. Average temperatures recorded in southern Taiwan at different elevations are indicated below.

Elevation (m)	Avg. temp. (C°)	Range (C°)
>3800	4	-2 to 8
3000	7.5	3 to 11.5
2000	13	6 to 17
1000	19	14 to 22.5
500	21	16 to 24

Recent rainfall records for the Tawu Mountain area indicate an annual rainfall of 4400-4800 mm, with a low in the dry winter months of approximately 50 mm/month, and a high in the rainy summer months of 500-800 mm/month. Not only do the watersheds receive some of the highest rainfall on the island (Fig. 3), but the record rainfall for Taiwan has also been recorded in this area. In 1934, the Taiwu Station, located west of Tawu Mountain, recorded 1,127 mm of rain in a 24-hour period.

E. Geology

The Tawu Mountain Nature Reserve consists of three basic geological formations, including the schists from the late Paleozoic and Mesozoic, the Pilushan Formation from the Eocene, and the Lushan Formation from the Miocene (Ho, 1988) (Fig. 4). The reserve is not on any active faults and there appears to be no appreciable seismic activity in the area, particularly compared with other parts of the island.

The pre-Tertiary metamorphic complex which is exposed mainly in the eastern part of the Central Mountain Range, including the Tawu Mountain Nature Reserve area, forms the oldest geologic element of Taiwan. The black or pelitic schists are the dominant schistose rocks exposed in the eastern part of the metamorphic complex. Their main constituent minerals include quartz, micas, chlorite, albite, sphene, and graphite, with minor amounts of epidote and pyrite. The greenschists are a second important member of the metamorphic complex and are composed of chlorite, epidote, quartz, calcite, biotite, albite, and actinolite. Siliceous schists, often associated with black schists and greenschists, include quartzite, quartzose schist, meta-chert, and schistose sandstone.

The Pilushan Formation includes all the undifferentiated Eocene rocks exposed in the Backbone Range belt. This formation is composed mainly of slate and phyllite with some thin to thick metamorphosed sandstone interbeds. The Lushan Formation is composed of argillite and slate of early Miocene or early middle Miocene age in the Backbone Range belt of the Central Mountain Range.

F. Water drainage and water quality

The current boundaries of the Tawu Mountain Nature Reserve encompass five watersheds that form the following waterways (North to South): Tanan River, Chipen River, Tamali River, Chinlun River, and Tachu River (Fig. 5). These watersheds support underground aquifers and provide surface water used by towns and villages to the east of the reserve. This will be discussed in more detail in another section.

Diagrammatic cross sections of four major watersheds within the boundaries of the reserve -- Chipen, Tamali, Chinlun, and Tachu -- indicate a large variation in sloping patterns and thus drainage both within and between waterways (Figs. 6 & 7). However, the slopes generally level off with subsequent widening of the river as one moves downstream.

Because of the natural state in which the watersheds still exist, the scientific teams investigated some key parameters of the water quality in the streams. These data indicate some baseline values for water quality in regions of little or no pollution, and thus could be of comparative value for both future monitoring in the Tawu Mountain area and for other areas of Taiwan. The work was carried out in four of the watersheds of the reserve: Chipen, Tamali, Chinlun, and Tachu. The parameters included water temperature (°C), dissolved oxygen (ppm), water pH, salinity (1/1000), soil moisture content (%), ammonia concentration (ppm), nitrite concentration (ppm), hydrogen sulfide (ppm), copper concentration (ppm), and iron concentration (ppm). Results are presented in Table 3.

G. Floral composition

Between 1986 and 1988, 105 vegetation sampling plots below 1000 m were set up in the Chipen, Tamali, Chinlun and Tachu River watersheds (Fig. 8). Aerial photo maps were used initially to locate natural forest stands in these areas. It was found that the Tamali watershed contained less human disturbance in the form of logging than the Tachu watershed.

These surveys resulted in the documentation of 137 families, 350 genera, and 517 species (Table 4). This taxonomic breakdown can be grouped into the following categories:

Ferns - 28 families, 56 genera, 83 species;
Gymnosperms - 4 families, 5 genera, 5 species;
Dicotyledons - 92 families, 232 genera, 362 species;
Monocotyledons - 13 families, 57 genera, 67 species.

Dominant vegetative associations at different altitudes are listed in Table 5. A pictorial comparison of major tree species associations along a river bank at 300 m, and those found within the major forest type of warm temperate broad-leaved forest at 680-720 m is depicted in Fig. 9. A similar comparison of plant species along the river and those within the warm temperate broad-leaved forest are presented in Tables 6 and 7.

H. Faunal composition

Between 1987 and 1988, zoologists from the Tawu Mountain scientific team led teams on 12 trips to conduct surveys in five areas of the proposed reserve (Fig. 5). Survey routes were on ridges and along

waterways. Techniques for assessing the presence of vertebrates included animal sightings, identification of spoor along trails and transects, scent posts on track pads of sifted dirt, small mammal trapping, fish netting, and talking with aboriginal hunters in the area. Sightings of butterflies were also recorded.

Due to time and weather constraints, the survey teams generally did not have the time to do complete vertebrate inventories, particularly for amphibians and reptiles. However, despite this, the following numbers of species were documented:

27 mammal species (Table 8) - 4 endemic species, 19 endemic subspecies, and 3 species listed as endangered under the Cultural Heritage Preservation Act.

74 bird species (Table 9) - 12 endemic species, 30 endemic subspecies, and 4 species listed as endangered under the Cultural Heritage Preservation Act.

9 amphibian species (Table 10) - 2 endemic species

18 reptile species (Table 11) - 2 endemic species, 2 endemic subspecies, and 1 species listed as endangered under the Cultural Heritage Preservation Act.

6 fish species (Table 12)

28 butterfly species (Table 13)

An additional list of 79 bird species - 4 endemic species, 27 endemic subspecies, and 3 species listed as endangered under the Cultural Heritage Preservation Act - that should be in the Tawu Mountain area

according to Chang (1985) but were not found during our inventories are listed in Table 14.

IV. Tawu Mountain Nature Reserve - Buffer Zones

A. Definition of buffer zones

An acceptable definition of a buffer zone was put forth by MacKinnon (1981), who states that buffer zones are "areas peripheral to national parks or reserves which have restrictions placed on their use to give an added layer of protection to the nature reserve and to compensate villagers for the loss of access to strict reserve areas."

Areas that are usually considered suitable for buffer zones consist primarily of forested habitat which cannot be given full protective status as a reserve for legal, economic, or political reasons. These areas often already have human settlements or other small scale multi-use activities going on within their borders. Although these areas cannot be immediately incorporated into the core area of the reserve, the forest is usually under government control, and the appropriate government agencies can agree to set restrictions on the area for the good of the reserve. When buffer areas incorporate tribal reservation or privately owned lands, sometimes agreements on the use of the land can be made that are of mutual benefit to both the reserve and the landowners.

Zones of restricted use, or buffers, are crucial for the optimal protection and management of reserve areas. These zones should be considered extensions of the reserve and managed in accordance with the management plan for the reserve. Lack of such buffer zones, which

often leads to uncontrolled encroachment and loss of the forested areas at the perimeters of a reserve, increases biological edge effects and allows the "eternal external threat" (Janzen, 1986) to impact directly on the core protected area itself. All of this serves to make the effective size of the protected area much smaller than the legal boundaries actually suggest.

B. Legal protection of buffer zones

Ideally a buffer zone should be set up so that it falls within the legally defined boundaries of a protected area and is covered by the same legislation. However, this is often not the case. When this is not possible, other forms of forest legislation must be drawn upon to implement suitable policies and management practices. This becomes a more complex form of integrated management but can still work to the benefit of the reserve area.

As a first step, the actual concept of buffer zone area must obtain government recognition. There is usually forest legislation already in place that dictates the activities on government owned multi-use forested areas. These areas are often called national forest, reserve forest, or public lands. The incorporation of the buffer zone concept into a country's forest legislation simply recognizes cases where these same multi-use forest lands border a fully protected reserve area. Thus, although the buffer zone's multi-use status may remain essentially the same, it becomes an area now associated with a reserve to be watched and managed more carefully. This concept allows for such an area, which lies outside of the totally restricted status of the reserve, to be acknowledged all the same as an important part of the management and

conservation of a reserve, and to have a somewhat higher protected status than an isolated piece of multi-use forest land. Eventually, as circumstances change, buffer zone areas may make a smooth legal transition into the main body of the reserve itself.

Examples of case studies along with some concepts concerned with the management of buffer zones in tropical forests has recently been published by IUCN (Oldfield, 1988).

C. Potential benefits of buffer zones

A buffer zone can not only provide most of the benefits of the reserve itself, but also can often lend added educational and social benefits because of its multi-use status. Activities can often be conducted in buffer zones that are restricted within the core reserve area. Furthermore, recreational activities which may be allowed within the reserve can sometimes be shifted to the buffer areas, thus relieving some of the impact upon the reserve. A summary of some of the potential benefits of buffer zones, and what is needed to achieve these benefits while maximizing protection to the reserve, is listed below (from Oldfield, 1988). Obviously not all of these potential benefits are applicable in every case.

Biological benefits:

1. Provides extra protection from human activities for the strictly protected core zone.
2. Protects the core reserve from biological changes.
3. Provides extra protection from storm damage.

4. Provides a larger forest unit for conservation with less species loss through edge effects.
5. Extends habitat and thus population size of large, wide ranging species.
6. Allows for a more natural boundary, relating to movements of species.
7. Provides a replenishment zone for core area species.

Social benefits:

8. Local people have access to traditionally utilized species.
9. People are often compensated for loss of access to the strictly protected core zone.
10. Local people participate in conservation of the protected area.
11. More land is available for education, recreation, and tourism.
12. Wildlife conservation becomes a part of local and regional rural development planning.
13. Traditional land rights of local people are safeguarded.
14. Conservation related employment is increased.

To achieve the above, the following criteria must be observed:

1. Tree cover and habitats should be maintained as much as possible in their natural state.
2. The vegetation of buffer zones should resemble that of the protected area, both in species composition and in physiognomy.
3. Buffer zones should be as biologically diverse as possible.

4. The physiognomy of the vegetation should be as heterogeneous and as stratified as possible.
5. The capacity of the ecosystem in the buffer zone to retain and recycle soil nutrients should be retained as far as possible.
6. Buffer zone activities should not have negative impact on the physical structure of the soil or on its water regulating capacity.
7. Exploitation of buffer zones should, when possible, make use of traditional, locally adapted lifestyles and resource management practices.

D. Western buffer zone of Tawu Mountain Nature Reserve

During the delineation of the boundaries of the Tawu Mountain Nature Reserve, it was decided that another piece of forest to the west of the Central Mountain Range was crucial in controlling access and maintaining the high elevation habitats and the watersheds to the east. Furthermore, intensive urban development and overpopulation in the lowlands on the western side of the island was posing an ever increasing threat to the forested foothills and mountain slopes west of Tawu Mountain. However, various human activities already taking place within this forested zone made it impossible to bring the area under immediate reserve status.

During a meeting between the Taiwan Forestry Bureau (TFB) and COA on November 5, 1987, an agreement was reached that the forested area to the west of the boundary was to be left outside of the Tawu

Mountain Nature Reserve (Appendix II), but was recognized as a buffer zone to the reserve. This buffer zone would be managed by TFB under their own management plan, and might eventually be incorporated into the main reserve when present activities in the area (such as mining) were completed.

The western buffer zone is an area of approximately 214 km^2 (Fig. 5) controlled by the Pingtung Forest District Office. The zone lies within two forest districts: Pingtung District, forest blocks 24-31, and Chaochou District, forest blocks 4-9, 12, 13, and 15. The major habitats comprising this zone are almost equally divided between natural conifer-broad-leaved mixed forest (26.5%), rocky open areas (23.8%), and natural broad-leaved forest (23.0%). More specific characteristics of this area are shown in Table 15.

E. Northern buffer zone of Tawu Mountain Nature Reserve

To the north of the boundary of Tawu Mountain Nature Reserve is another continuous large block of national forest land. Much of this forest is rugged and uninhabited and comprises another water catchment area. At least one section of this area, called the Twin Ghost Lake region (Appendix III), has already been recommended for protection because of its biological and cultural importance to Taiwan (Chang et al., 1985). This area was not incorporated into the main body of the reserve because of political considerations and because accessibility into the area is still difficult. Therefore, it was decided that we would protect other biologically rich watershed areas that needed more immediate attention. This northern forested area was to be a buffer zone for the

main reserve which we would try and get into reserve status at a later time.

Thus for the present, a section of clearly delineated forest north of Tawu Mountain Nature Reserve is considered the second buffer zone of the reserve. This area resides within four forest districts and crosses county lines, and is under the control of both Pingtung and Taitung Forest District Offices. The forest blocks that comprise this buffer zone and the local offices responsible for its protection and management are listed below.

Taitung Forest District Office - Taitung County

Yanping District - Forest blocks 18, 19, 21-27, 32-34

Taitung District - Forest blocks 4-17, 27-34

Pingtung Forest District Office - Pingtung and Kaohsiong County

Pingtung District - Forest blocks 21-23

Laonoshi District - Forest blocks 4-12

V. Socio-cultural Factors and Resource Use in Tawu Mountain Area

A. Resource use within and outside Tawu Mountain Nature Reserve

Although in the past, parts of what is presently Tawu Mountain Nature Reserve have had small scale land use operations, the area's natural flora was never severely disturbed. Some blocks (Taitung District, blocks 21-26) were cut for planting operations; other blocks were logged. The sections that were logged were within Tawu District and comprised 150 ha in block 14 (1969) and 108 ha in block 19 (1974). Sections in Taitung District, blocks 38 and 39, were scheduled to be logged in 1990, but permission was cancelled upon creation of the reserve. Other operations that have taken place within the Tawu Mountain region until the area was declared a reserve (Appendix IV) include the harvesting of rattan vines beginning in April 1987 (Tawu District, forest blocks 9, 10, 13, 20, 24). Several small mining operations (forest block 44) occupying an area of 2.4 ha are located on the perimeter of the reserve in the western buffer zone. Another small mining operation is also located on the eastern perimeter of the reserve.

Outside of the reserve, in addition to the sizeable forested buffer areas to the west and north, there still remain portions of forest around the eastern and southern boundaries. To the immediate south of the reserve, there is a forested military installation (forest block 16) and a very small (0.8 km^2) nature reserve (forest block 39). This reserve, the Tawu Taiwan Amentotaxus Nature Reserve protects more than 400 trees of the rare and endangered *Amentotaxus formosana*, an endemic species

existing at only three other locations on the island. Adjacent to the two forest blocks containing the military installation and the small nature reserve is an additional small piece of forest (blocks 36, 37) which is not currently under protected status other than designation as national forest. These two blocks should be added to the boundaries of the larger Tawu Mountain Nature Reserve as soon as possible in order to further protect the small reserve and to round off the buffer area to the south.

On the eastern perimeter, in the mountainous region outside of the reserve, the law sets aside reservation lands for aboriginal use only. The aboriginal communities in this region are primarily involved in small scale agriculture. However, another of their practices, namely hunting, is of major concern to the management of the Tawu Mountain Nature Reserve and will be discussed in a later section. The Han Chinese community, who are settled on privately owned land outside of the reserve, also maintain small agricultural plots in the area, usually in the lowlands.

One of the major resources that the Tawu Mountain Nature Reserve provides free of charge to the public is water. All of the human settlements to the east of the reserve rely on the Tawu Mountain watersheds (part of the Central Mountain Range, Mainland Plate) for their drinking and irrigation water. The only other water source for some communities is the East Coast Mountain Range (Philippine Plate). The city of Taitung contains a population of 180,000 people who obtain water from the Tanan River; the town of Tamali pumps up ground water from the aquifer fed by the Tamali River; Chipen and the Chipen Recreation Area, which in 1988 was visited by 125,968 tourists, use water from

Chipen River; Chinlun uses water from Chinlun River; small settlements such as Tuban, Taiban, and Tashi use water from the Tachu River.

B. Human settlement patterns in the Tawu Mountain area

1. Aboriginal settlement

The region adjacent to the eastern boundary of the reserve is classified as the southern mountainous reservation area with the Rukai and Paiwan tribal people forming the main communities (Fig. 10). The Paiwan are by far the more abundant and, as of 1964, comprised 19% of all individuals making up the 9 Formosan aboriginal groups. The Rukai, in comparison, comprised only 2.7% (Wei and Wang, 1966). While the reservation areas are for aboriginal use only, as one moves toward the coastal lowlands, land is distributed according to private ownership and can be rented or sold. There are Han Chinese as well as aborigines settled in these areas.

In earlier times when the aborigines were primarily slash-and-burn agriculturists as well as hunters, they would move their settlements frequently within the mountain areas. However, by the middle of the 18th century, the aboriginal way of life and settlement patterns began to change with the migration of large numbers of Han Chinese from the mainland to Taiwan. Even more abrupt changes occurred in the 1930's when the Japanese occupied Taiwan. The Japanese forced the aborigines to become more concentrated in areas outside or on the perimeter of the mountains. Many of them were forced to take on a more sedentary way of life, planting crops such as rice.

By 1965, socio-cultural changes forced upon the aborigines resulted in their mountain settlements having greatly decreased in number. Most settlements were below 1000 m, with only the Atayal and Rukai above 2000 m. The Paiwan people moved from the mountains to the western hilly flanks. Some of them did not accept wet-rice planting and moved back into the mountains for slash and burn agriculture. Overall, there was a decrease in the number of aboriginal settlements, but a large increase in the number of individuals within a settlement. Different tribal groups reacted to these changes in different ways, often depending on their degree of ethnocentricity. Over the years all tribal groups increased in numbers but to different degrees. Between 1939-1964, the Paiwan increased their population by 353%, while the Rukai increased only 9%.

Today the mountain aborigines, such as the Paiwan and Rukai, live in semi-forested areas in the foothills of the mountains. Their basic way of life still involves small scale agriculture producing crops such as millet, sweet potatoes, taro, vegetables, fruits, and mushrooms. However, drastic cultural and economic changes have occurred in their way of life over the last 30 years. These changes, which have clearly affected their traditional practices, must be understood in order to properly work and interact with them in the protection of the Tawu Mountain Nature Reserve.

For more detailed information concerning aboriginal settlement patterns throughout Taiwan see Wei and Wang (1966).

2. Socio-economic changes among the aborigines

The 1950's and 1960's were times of major economic change in Taiwan which saw a transition from a primarily agricultural to an industrialized nation. Although these changes affected both the aborigines and the Han Chinese culturally and economically, they were not affected to the same extent.

One of the most important indices of how extensively a culture can be affected by changes in its traditional way of life involves looking at changes in levels of education. From 1953-1978, illiteracy among the mountain aborigines dropped from 33% to 8%. However, as of 1978 still only 6.5% received a high school education (versus 15% for the average population), and less than 1% attended university (versus 5% for the average population). When aboriginal people were asked what they believed to be the reasons behind poor performance and low grades by aboriginal children in school, the aborigines with higher education said that they believed it was related to the lack of interest in education by the parents. Yet, aborigines with lower education believed that poor school performance was related to a parent's financial situation and to the students themselves.

Economically, the average income of the mountain aborigines between 1953 and 1978 increased from NT$3,930/family to NT$112,668/family. Yet, as of 1978, the average income of the mountain aborigines was still only 40% that of an average Han Chinese farmer. A rural, more traditional way of life which included agriculture, animal husbandry, forestry, and fishing, dropped from 96% in 1953

(61% for the whole province) to 75% in 1978 (36% for the whole province). Consequently, the income of the mountain aborigines from agriculture, dropped from 81% in 1953 to 45% in 1978. The same trends were seen among the lowland aborigines.

With changes such as these, a change in the family and community structural unit could almost be expected. In less than a ten year period, between 1969 and 1978, the percentage of both lowland and mountain aborigines who were working in places other than their hometown went from 3.5% (5% males, 2% females) to 12% (15% males, 8% females). More recent surveys indicate that up to 33% of the young people in a community may be working in places other than their homeland.

For more detailed information on past and present socio-economic patterns among the aborigines, see Lee et al (1983).

3. Local settlement by Han Chinese

In addition to aboriginal reservations and villages, there are sizeable numbers of Han Chinese settled primarily in the lowlands. The largest city in the area, Taitung, consists mostly of Han Chinese, while smaller areas such as Tamali are comprised of both Han Chinese and aborigines. Some Han Chinese are involved in agriculture while others are merchants and local officials in the towns. Taitung is the poorest county in Taiwan with an average annual per capita income of NT$283,995/year compared to the average annual per capita income in Taiwan of NT$399,289/year. Taitung has a larger aboriginal population than any other county. Many of the local Han Chinese feel that their

region is the most "backward" in Taiwan, and deserves more attention from the Central Government in stimulating more rapid economic growth.

C. Hunting activities in Tawu Mountain area

1. Hunting methods - past vs. present

Hunting has always been a major and important aspect of the traditional way of life of the aboriginal tribes. Chen (1988) states that even though agriculture has been the most important means of livelihood for the Formosan aborigines, both hunting and agriculture were of equal importance in the daily life of the mountain people. Even agrarian rituals were not purely agricultural, but referred also to hunting. However, with the general trend of tribal movement out of the mountainous areas, and with accompanying changes in economic and cultural conditions such as those documented previously, the numbers of aborigines engaging in serious hunting has dropped greatly since earlier times. Yet ironically, the numbers of animals of most wildlife species in Taiwan are lower now than ever before; thus any hunting pressure on these species may have considerable effect. Causes of this decline involve greatly decreased wildlife habitat, including nearly total loss of the lowlands, and more modern, indiscriminate and often wasteful hunting methods.

At about the time of the Japanese occupation, hunting was still carried out in a more "traditional" manner. Hunting groups often consisted of ten to thirty persons armed with bows and arrows, spears, and self-made guns. The harvest of animals was primarily for self-use

and special ceremonies. Certain key species such as the clouded leopard were sold to the Japanese for their skins.

Documentation of present hunting methods indicate that hunting is no longer carried out in a traditional manner, nor does it seem to be an integral component of the life of a community. Now hunting is often carried out alone or in groups of three to five, usually in the winter dry season when there is easier accessibility into the mountain areas and when crop growing season is over. Hunters now use leg-hold traps and snares for capturing animals, with steel jaw traps being the more favored method. Dozens of traps may be set along streams and animal trails, and hunters might not return for either three to five or seven to ten days to check the traps. Because of this process the meat of a captured animal is sometimes spoiled, or trapped animals are killed and eaten by other wild animals; the animal often dies a slow and painful death, or chews through its own body part in order to free itself from the trap.

The areas in which particular hunters choose to set traps are usually regulated by both the hunting grounds that traditionally belong to a tribe, and the smaller hunting area that belongs to an individual hunter. Although these traditional boundaries are not as strictly adhered to as in the past, some older hunters still feel that certain areas are theirs by right.

2. Use of captured wildlife

a. Hunters

Among 161 hunters interviewed, only 10% claimed to be earning a living by hunting, while the remaining 90% did other work for a living. Although 40% of the hunters said they hunted year-round, most of the hunting was concentrated between October and March. The species that hunters preferred to hunt included wild boar, flying squirrel, muntjac, and serow. The remaining wildlife was divided by hunters into the following three categories:

Most abundant species: Flying squirrel, monkey, wild boar, serow, muntjac, gem-faced civet, hare.

Common species: Ferret-badger, weasel

Rare species: Sambar deer, bear, pangolin, Chinese civet, mongoose, leopard cat.

However, despite these categories, hunters felt that most animal species have declined in numbers in recent years. Sambar deer, serow, muntjac, and pangolin were said to have shown the most drastic declines, while flying squirrel, monkey and weasel showed the least decline. The most common species hunted and traded, the flying squirrel, was used in various ways by the aborigines. They generally ate the meat and inner organs, then made the skin into a decorative piece for sale outside their village. Because the ferret-badger and mongoose are not often eaten, the market for these animals is small and hunters are not motivated to capture them purposefully.

Hunters said that their reasons for hunting included commercial exploitation, traditional custom, recreation and food support. However, since 63% of hunters surveyed reported that they sold part or most of their harvest, commercial exploitation appeared to be the strongest motivation of the hunters. Yan (1979) reported that many tribal people were traditionally against the killing of leopard cats. However, since leopard cats currently fetch a high price, many hunters interviewed (44%) claimed they wanted to capture one. Hunters indicated that, on a good trapline, they could easily make more money by hunting than their average daily wage at doing other work. Reasons for hunting such as recreation and custom are occasionally cited by older hunters, but very rarely by younger ones. Although 75% of the aboriginal hunters cited hunting as a source of food support, it appeared that other sources of meat were readily available. Hunted animals seemed to be used primarily to cut down expenses, and also because some hunters believed that game meat contains more nutrients.

The preference of hunters to catch certain species over others is affected by abundance, catchability, size, market price, quality of meat, and distribution of the animal. Animals such as wild boar, muntjac, and serow are large, traditional game animals, and most preferred by hunters. Flying squirrel is abundant, easily captured, and the aborigines like to eat the inner organs. Monkeys are preferred as pets and food, and gem-faced civets are preferred because of their popularity as market animals. Although species such as sambar deer, hare, and pangolin fetch a good market price, hunters claim they are hard to catch and, in some cases, locally distributed. Thus these species are preferred to a

lesser extent. Leopard cat, which is locally distributed, and bear, which is considered dangerous, are also less preferred. The least preferred species include mongoose, Chinese civet, ferret-badger, and weasel. The meat of most of these species is said to smell bad and many game shops do not want to purchase them.

b. Game shops

Surveys of game shops and hunters throughout Taiwan indicate that trade in wildlife is still a relatively thriving business. Of 78 game shops located and interviewed, 41% were in southern Taiwan, which contained the highest density of game shops; 35% were located in eastern Taiwan, and 24% in central and northern Taiwan. Of these shops, 50% were either game shops only or game shops in combination with a restaurant selling game meat. Among the remaining 50%, 23% sold game and other forest products and 27% were game shops along with some other business. Game shops lasted an average of 15 years, with specialized game shops lasting ten years longer than shops doing other business at the same time. Specialized game shops generally got their animals directly from the hunters. Game shop owners claimed that over 70% of these hunters were aborigines.

The best business season was generally between September through February with peak season in November and December. The general volume of trade for different species indicated that the most popular species (in order of trade volume) were flying squirrel, gem-faced civet, muntjac, hare, and wild boar. Monkey, serow, ferret-badger,

mongoose, and sambar deer were sold less often. Pangolin, Chinese civet, leopard cat, weasel, and bear were the least traded species.

The prices for different species were highest for bear and sambar deer, about NT$40,000-120,000/animal. Other species such as otter, leopard cat, and yellow-throated marten were also expensive at about NT$8000-30,000/animal. Expensive animals sold primarily for meat included gem-faced civet and pangolin, priced at about NT$600/pound. Other animals sold for meat were generally priced at about NT$200-250/pound. Sources of game meat include mainly Yilan, Hualien, and Taitung Counties.

Younger animals, or adult animals of species able to breed in captivity, were higher priced than others. There was a large variation in prices between game shops in different parts of Taiwan, with those in the east and south generally having lower prices. The general feeling of the game shop owners was that species such as muntjac and serow may still be quite abundant, while pangolin and sambar deer have decreased drastically. Species such as bear and otter will become endangered or extirpated from certain areas if hunting is not controlled.

In the discussion of the survey report (Wang, 1986), it is stated that traditional aboriginal game animals such as wild boar, muntjac, serow, gem-faced civet and hare are most favored by customers and thus have a large market. Although the population of muntjac in the wild may still be relatively high, their numbers have dropped drastically due to heavy trapping pressure. The population of species such as hare may still be relatively stable, but not evenly distributed. Because of the

popularity of breeding species such as gem-faced civet and wild boar in captivity, their numbers may still be relatively high in the wild. Species such as pangolin, sambar deer, black bear, Chinese civet, and leopard cat are rare and not easily seen or captured. These animals are used mainly for expensive medicinal purposes. Monkey, though often seen in the wild, do not have a high trade volume because it is not a popular game meat. Yet it is a traditional game animal, often hunted by the aborigines.

The survey indicates that game shop owners are currently facing problems of animal shortages, competition among game shops, and laws against hunting. It is predicted that some owners, particularly those involved in other things, will stop being involved in wild game trade in the future.

For more detailed information regarding surveys of hunters and game shops see Wang (1986) and Wang and Lin (1987).

VI. Legal Management and Protection of Tawu Mountain Nature Reserve

A chart indicating the general chain of command involved in creation and administration of Tawu Mountain Nature Reserve is shown in Fig 11. The basic protection and monitoring of the reserve and its buffer zones will occur at the level of the local forest district offices. The reserve itself, as well as part of the northern buffer zone, is within the jurisdiction of the Taitung Forest District Office, while the western buffer zone and part of the northern buffer zone are within the jurisdiction of the Pingtung Forest District Office. These local forest district offices are under the immediate control of the Taiwan Forestry Bureau (TFB), which falls under the Provincial Agriculture and Forestry Department. TFB should have a clear understanding of this management strategy so that they can help direct the actions of the local offices. The Tawu Mountain Nature Reserve itself comprises 21% of the Taitung District (227,852 ha) and thus should be given high priority for utilization of manpower in protecting and properly managing the area. For the buffer zone areas, TFB has its own management policies, which should be coordinated with the long term strategy for the Tawu Mountain Nature Reserve. Oversight and financial assistance for carrying out this management strategy will be a joint responsibility of TFB and COA.

In the initial stages of this strategy, two committees will be set up for Tawu Mountain Nature Reserve. The first, the Tawu Mountain Administrative Committee, will be comprised primarily of government officials (such as COA and TFB) who will be responsible for recommending legal and financial action regarding Tawu Mountain

Nature Reserve to the Central Government. The second, the Tawu Mountain Scientific Advisory Group, will consist of scientists who will oversee and continually evaluate the management strategy, and who will then make recommendations to the Tawu Mountain Administrative Committee.

One of the main problems involved in the protection of the Tawu Mountain area is that of law enforcement. Although forestry officials will be sent to patrol the reserve area, they have no power of law enforcement. When violations occur, the forestry officials must obtain the cooperation of the local police. It has been stated that in the past, the local police have been less than fully cooperative regarding such violations. This must be discussed and at least partially rectified in the early stages of the strategy. Such problems should be brought to the attention of the Tawu Mountain Administrative Committee.

VII. Current and Potential Threats to Tawu Mountain Nature Reserve

A. Hunting and collecting

The major threats to the Tawu Mountain Nature Reserve by the aboriginal people include activities such as hunting and plant collecting. Hunting has been discussed at length in a previous section. Collection of plants such as orchids is done in a manner that overexploits the resource and is a potential threat to the integrity of the forest community. Hunting is a particularly serious threat and must be dealt with quickly and firmly. The evidence of constant and intensive poaching within the reserve boundaries has been overwhelming. This activity threatens to virtually wipe out much of the remaining wildlife within the reserve because of indiscriminate and wasteful hunting methods. Unless strong measures are immediately taken to prevent further exploitation of the flora and fauna within the reserve, the future well-being of the reserve is in grave jeopardy. Threats to the reserve that involve the potential loss of plant and animal life involve the loss of biological diversity and potential changes in community structure and stability.

Hunting by local Han Chinese has also taken place within the Tawu Mountain area. Hunting by Han Chinese is often conducted with guns using local aborigines as guides. In one case, witnessed by one of the Tawu Mountain survey teams, two aboriginal area check station police led several Han Chinese hunters into an area that is presently within the reserve. The members of the survey team witnessed 16 flying squirrels killed and heard gunshots all through the night.

B. Uncontrolled visitation

Visitation in the form of local hikers, sightseers, and anyone visiting the area for recreational purposes is a form of uncontrolled activity that currently occurs within the Tawu Mountain Nature Reserve. Areas such as Little Ghost Lake within the reserve, as well as other parts of the Twin Ghost Lakes region in the northern buffer zone of the reserve, are extremely popular recreational areas. Little Ghost Lake already has road access to within two hours of the lake, and workers from a mining operation in the area say it is not uncommon for them to observe from several hundred to more than a thousand people visit the lake over a weekend. The road access to this lake was built by one of the mining operations.

Several hot springs within the reserve are also popular recreational areas, though to a much lesser extent. One particular hot spring several hours hike into the reserve had an illegal commercial operation set up for campers. The operation was dismantled when the area was declared a reserve. Within the western buffer zone there is a well built and very popular trail with steps going right up to the summit of North Tawu Mountain. Access to such high elevation areas should be closely controlled because such areas contain special and easily disturbed habitats.

Apart from the local hunting, which must be stopped, visitation and recreational usage of the Tawu Mountain Nature Reserve, particularly in the buffer areas, may not be detrimental for its well-being. In fact, the reverse might be true. If such visitation is properly controlled

and managed, then certain sites within the reserve can be fully enjoyed by visitors while having an educational impact as well. Although the main purpose of the reserve is to maintain the integrity and well-being of the natural environment, a secondary purpose should be to educate and help people to appreciate the beauty and importance of nature. Such a purpose can be achieved through controlled access into certain areas, as well as the establishment of special hiking and camping areas which are patrolled and have brochures and/or signs that help teach the people about the environment around them.

C. Mining

There are eight mining operations currently active around the perimeter of the reserve (Fig. 12). Seven of the mines are for marble (four in the vicinity of Little Ghost Lake, two near South Tawu Mountain, and one near Wutou Mountain) and are located within the western buffer zone area. The eighth mining operation is for crystal, and is located outside the eastern boundary of Tawu Mountain Nature Reserve.

Although such operations claim to "affect" only a small forested area, in reality they have a much larger and more long lasting effect than one might think. Because such mining operations must cut into mountainsides, they often do severe and long lasting damage to the surrounding landscape and its associated flora and fauna because of such things as erosion, siltation, and potential pollution of the waterways in the area. Roads and other cleared areas that are needed to build and access the mining camp and the mining operation do additional damage by clearing nontargeted forest lands and by

compacting the soil to such an extent that it takes many years before the natural vegetation is able to grow back. However, one of the most long lasting and detrimental effects of these operations are the roads that are built into a forested area. Such access permits easy and often year round entry by local hunters and other visitors into forested areas which might have been very difficult to get into otherwise.

D. Road construction

One of the most current threats to the Tawu Mountain Nature Reserve is a plan to built another cross island highway through the northernmost section of the reserve. Such a road would be detrimental for the current and future management and protection of the reserve. The proposed road would cut between and potentially affect two of the main watersheds in the reserve, Tanan and Chipen (Fig. 13). As mentioned previously, the Tanan watershed is the source of both drinking and irrigation water for Taitung city. Furthermore, according to the building code of Taiwan (Fig. 14), the Tawu Mountain Nature Reserve is situated within an area of maximum earthquake hazard.

Any construction of this kind which needs to cut into steep mountain slopes must be carefully considered. It is these steep sloped areas which have the greatest potential for faulting or mylonitic seams. As has happened with the other cross island highways, this kind of construction can cause severe landslide and erosion problems which need constant and costly maintenance, and can affect the ecological environment of the area.

Another and perhaps the most detrimental effect of such a road through the Tawu Mountain Nature Reserve is the sectioning of the reserve and the infringement into the core area. Some of the original reasons for delineating the boundaries and the buffer zones as they currently exist for the reserve was for optimal protection of the core area itself. A road passing through the heart of the reserve will not only negate such intentions, but will allow uncontrolled, year round access into remote and difficult to reach areas. Hunters who would have had to walk several days through rugged forest would then be able to drive right into rich wildlife habitat and set their traps.

Allowing such a road through Tawu Mountain Nature Reserve would not only be ecologically detrimental to the natural habitats of the protected area, but would set a very bad precedent for Taiwan. If solutions cannot be found so that the integrity of this very important natural area remains intact, then the future of good conservation efforts and resource management in Taiwan is in serious doubt.

VIII. Management and Conservation of Tawu Mountain Nature Reserve

A. Reasons for the reserve

The Tawu Mountain Nature Reserve was created to preserve and protect a natural part of the ecosystem of Taiwan. This reserve encompasses one of the few large remaining pieces of natural, uninhabited low-middle elevation forest left on Taiwan. It is a region that not only contains some of the most abundant wildlife populations remaining on the island, but protects a wide biological diversity that includes endemic species and subspecies found nowhere else in the world. The objective of this management strategy is to protect the Tawu Mountain Nature Reserve to the fullest extent possible, while allowing it to be of positive benefit to the people of Taiwan. In protecting this reserve, the broad goals of this strategy encompass these three concepts:

1. Maintenance of biological diversity
2. Watershed protection
3. Ecosystem stability

B. Potential benefits of protection of the reserve

By protecting and properly managing the Tawu Mountain Nature Reserve and its buffer zones, Taiwan will not only be preserving one of the last rich pieces of its natural heritage for people to continually enjoy, but will also be preserving a living laboratory. Tawu Mountain Nature Reserve can be used for biological research, environmental monitoring, education and recreation. In addition, it can have socio-economic

benefits for the local people. This reserve will lead to possible employment of local aborigines as guides and wardens; it will protect a piece of their cultural heritage and it will continue to help maintain water resources and fertile agricultural land through controlling environmental degradation such as flooding, erosion, and siltation.

The enjoyment of the forest and its use for recreational purposes is playing an increasingly large role in the lives of the people of Taiwan. Chipen Recreational Area, a forested area approximately 11 km from Tawu Mountain Nature Reserve, has shown drastic changes in visitation rates over recent years. This forest recreation area, which was only ninth in number of visitors for forest recreation areas in Taiwan, showed an increase from approximately 10,000 visitors in 1985, to nearly 70,000 visitors in 1986, 92,000 visitors in 1987, and 126,000 in 1988. This obviously growing need for forest recreation can at least be partially met through controlled visitation in special reserves such as Tawu Mountain.

C. Basic premise of a management plan for the reserve

The ultimate goal of this management strategy is to protect and conserve the Tawu Mountain Nature Reserve by stopping any present or future environmental degradation of the area. This calls for:

1. Not allowing any subdivision of the reserve area.
2. Preventing any form of habitat degradation.
3. Increasing the protection of the core area by increasing the size of the reserve and maintaining strict control over buffer zones around the reserve.

IX. Five Year Management and Conservation Strategy for Tawu Mountain Nature Reserve - Outline

A. Year 1

Major objective: To secure protection and remove all immediate threats to the reserve while initiating a local information network pertaining to the protection of Tawu Mountain Nature Reserve.

The following activities are recommended for the first year:

1. Set up a Tawu Mountain Administrative Committee of government personnel
2. Set up a Tawu Mountain Scientific Advisory Group
3. Broad distribution of management plan
4. Workshop for management plan implementation
5. Immediate and regular schedule of poaching patrols/trap removal
6. Identify all known and potential routes of access into the reserve
7. Post signs/warnings at all known access points
8. Identify individuals with traditional hunting rights in reserve
9. Hire influential villager as an information officer
10. Stop all immediate threats to the reserve
11. Establish and present to the government a clear and concise definition of a buffer zone
12. Monitor the management of the western buffer zone area by TFB
13. Incorporate two southern forest blocks into the reserve
14. Conduct surveys into northern buffer zone
15. Clarify the laws regarding recreational and/or scientific activities within the reserve

16. Investigate the current level of recreational use of the reserve
17. Develop a set of informative posters/brochures for the reserve
18. Organize talks/slide shows at schools and village councils
19. Build small guard station/checkpoints at major access points
20. Build small information centers in major villages near reserve
21. Continue basic inventory research
22. Expand basic research to investigate baseline abundance data
23. Identify sites to set up permanent environmental monitoring stations
24. Conduct a first year evaluation by Tawu Mountain Scientific Advisory Group

B. Years 2-3

Major objective: Firmly establish the management and protection of Tawu Mountain Nature Reserve while increasing environmental awareness and research in the area.

The following activities are recommended for the second and third years:

1. Set up a Tawu Mountain Nature Reserve manager position
2. Field workshop to train guards in basic monitoring work
3. Classroom/field workshop for teachers/local officials in area
4. Increase guards and poaching patrols
5. Build backcountry guard and monitoring stations
6. More permanent guard stations/checkpoints at main entrances
7. Continue to check on major hunting families who use Tawu Mountain area
8. Expand at least one information center into a visitor center

9. Control and possibly develop visitation to recreational areas
10. Legal recognition of buffer zone areas
11. Incorporate northern buffer zone into the reserve
12. Continue to work with TFB and local government on usage of buffer zones
13. Set up at least two long term monitoring stations
14. Research inventories - emphasis on relative abundance and diversity
15. Develop special student research fund for work in reserve
16. Try to visit all areas within reserve - document key areas
17. Continue to document illegal disturbances
18. Organize a meeting of Tawu Mountain Administrative Committee - second year
19. Evaluation by Tawu Mountain Scientific Advisory Group - second and third years

C. Years 4-5

Major objective: To secure and extend the protection of the areas around the core reserve and to evaluate future use and protection of the area.

The following activities are recommended for the fourth and fifth years:

1. Conduct fourth year evaluation by Tawu Mountain Administrative Committee
2. Evaluation by Tawu Mountain Scientific Advisory Group - fourth and fifth years
3. Update management plan for the Tawu Mountain Nature Reserve
4. Detailed comprehensive research on key wildlife species

5. Maintain special student research fund for work in reserve
6. Guidebook to the Tawu Mountain Nature Reserve
7. Monitor new northern reserve area
8. Monitor and assess remaining buffer zone areas around the reserve
9. Increase long term monitoring stations in different watersheds
10. Formalize position and responsibilities of the reserve manager
11. Evaluate need for hiring an assistant to the reserve manager
12. Evaluate wildlife trade and hunter attitudes around reserve
13. Maintain and possibly increase forest patrols
14. Increase the function and capabilities of the visitor and information centers
15. Further develop trails and facilities at key recreational areas
16. Public awareness campaign on accomplishments of Tawu Mountain Nature Reserve

X. Five Year Management and Conservation Strategy for Tawu Mountain Nature Reserve - Detailed

A. Year 1

1. Set up a Tawu Mountain Administrative Committee of government personnel

An administrative committee consisting primarily of government personnel should be set up in the early stages of this plan. Such a committee should be comprised of high ranking officials from government agencies involved in nature conservation, the environment, and the protection and management of Tawu Mountain Nature Reserve. The committee should be chaired by the Vice-Chairman of COA. The functions of the committee will include acting upon administrative, legal, and financial recommendations from the Tawu Mountain Scientific Advisory Group. It is recommended that, during the first year, arrangements should be made for the chairpersons of both the Administrative Committee and the Scientific Advisory Group to visit the reserve for purposes of public relations and as a means for becoming more familiar with the area and its operations.

2. Set up a Tawu Mountain Scientific Advisory Group

The current coordinators of the Tawu Mountain survey teams should be formalized into a scientific oversight and advisory group chaired initially by Dr. Ling-Ling Lee, zoology professor from National Taiwan University. The purpose of this committee will be to ensure that the management strategy is carried out to the fullest extent possible.

The committee will have annual meetings and will report any actions or recommendations directly to the chairperson of the Tawu Mountain Administrative Committee.

3. Broad distribution of management plan

In order to make certain that all levels of government bureaucracy are aware of the plans for protection and management of Tawu Mountain Nature Reserve, copies of the management plan should be widely distributed among members of the central, provincial, and local government involved in control and potential development of the Tawu Mountain Nature Reserve. This would include members of the Executive Yuan, Council of Agriculture, Council for Economic Planning and Development, Environmental Protection Administration, Taiwan Forestry Bureau, and local forest district offices which have jurisdiction over either the Tawu Mountain Nature Reserve or the buffer zones of the reserve.

The strategy should also be circulated to other government offices involved in protection and management of other protected areas in Taiwan. This would include the Planning and Construction Administration, National Park Department, and National Park superintendents.

4. Workshop for management plan implementation

A workshop will be held consisting primarily of officials from the local forest district offices responsible for the protection of Tawu Mountain Nature Reserve and its buffer zones. This workshop should

explain the reasons behind the protection of the Tawu Mountain Nature Reserve and how the local officials can properly carry out the recommendations of the management plan. Members of the local police force, who will be responsible for handling illegal activities in the reserve, as well as certain aboriginal hunters or village headmen, might also be encouraged to attend the workshop. The workshop should incorporate a detailed slide show to familiarize people with the scenic beauty and special habitats of the reserve. The workshop need not be more than 2-3 days long and may include a trip into Tawu Mountain Nature Reserve.

5. Immediate and regular schedule of poaching patrols/trap removal

Within the first year, intensive efforts should be made to stop illegal hunting within the reserve boundaries and to confiscate all illegally set traps. Members of the local forest district offices will have to work in close conjunction with the local police force if individuals are to be confronted. However, when members of the forest district offices must work alone, they should intensively search for and confiscate traps, as well as warn local hunters about the restrictions in the area.

During the first year, optimal patrol and surveillance will call for at least twenty permanently assigned forest officers, working in teams of three to four, patrolling the different watersheds of the reserve. Aboriginal hunters or guides should be employed as members of these teams if possible. Surveillance and patrolling of the area should begin immediately along existing waterway access and along major hunting trails.

Surveillance should occur a minimum of four times weekly, but should be scheduled randomly so that a set schedule cannot be known or anticipated by hunters. Surveillance should include two components - overnight patrols at least two to three times a month which visit key areas and occasionally go deep into the reserve for several nights, and the stationing of guards at waterways and other main entrances to the reserve to check on and record hunter movements. This surveillance will help to establish a noticeable presence in the area. An extensive sweep of the more heavily used areas of the reserve should be conducted by large teams of forest guards in the first few months in order to immediately confiscate large numbers of traps, and to let hunters in the area know of the seriousness of the intention to protect the reserve. Even when confrontation with hunters is not possible, an obvious record of their movements and presence might help to discourage them, and will assist in gathering information on their hunting areas and in documenting what species are being removed. Names and documentation regarding individuals observed, or known to be in the area repeatedly, should be taken to the local police. Any lack of cooperation from the local police should be reported to the Advisory Group and ultimately to the Tawu Mountain Administrative Committee.

It is assumed that all patrolling efforts will be coordinated by the forest district offices in the area. Therefore, any funds needed for hiring extra staff to patrol Tawu Mountain Nature Reserve will come through TFB and be channeled to the local offices.

6. Identify all known and potential routes of access into the reserve

Attempts should be made during both dry and rainy season to document the routes by which hunters and others currently gain access into the reserve. These routes should then be patrolled regularly according to their patterns of use. It is understood that most patrolling efforts will probably occur during dry season when there is easy access into the area and when most of the hunting is done. However, patrolling should be carried out during the rainy months to document use and access of the area during these months.

7. Post signs/warnings at all known access points

The reserve should be posted with large, well built signs at the entrances to the major watersheds, and smaller signs along access trails in the interior informing the public of the status of the area and the restrictions. Informative and colorful posters should be put in nearby towns and villages. As much of the boundary of the reserve should be posted as possible. The larger signs should explain that attempts will be made to prosecute violators of this reserve.

8. Identify individuals with traditional hunting rights in reserve

Because of the system of allocating hunting areas to particular individuals of an aboriginal group, most of the illegal hunting in the Tawu Mountain region may be carried out by a select group of individuals. Efforts should be made to identify these individuals and talk with them. They should be made aware that we know of their activities and that we would very much appreciate their "help" in curtailing illegal

hunting activities. These people should be approached as friends, not opponents, and materials relating to Tawu Mountain Nature Reserve, such as posters and brochures, should be given to them. If willing, they can be employed as temporary guides to assist in patrols and trap confiscation. Periodic visits should be made to these people's houses in order to maintain contact and stay aware of their activities.

9. Hire influential villager as an information officer

In the village(s) in which many of the hunters in the Tawu Mountain area live, a particularly influential individual should be hired as an information officer. This person could be a village headman, a member of one of the main hunting families, or a local school teacher. This individual will be paid a small stipend to disseminate information in the form of brochures and posters about Tawu Mountain Nature Reserve. He could give talks in local schools and could be involved in the local planning workshops in the area. Part of his job would also be to help set up and maintain the local information centers to be built in various villages. The job can, initially, be either full or part time according to the needs of the area.

10. Stop all immediate threats to the reserve

The long term success of the management and conservation of the Tawu Mountain Nature Reserve rests in the ability of the government agencies to stop the potentially disastrous threats to the Tawu Mountain area. The threat of constant poaching can only be stopped by funds made available for guards and constant, intensive poaching patrols. Efforts must be made at the local level to obtain the fullest possible

cooperation from the local forest district offices and from the local police departments. The potential threats posed by the mining concessions along the boundaries of the reserve should be alleviated by not renewing or issuing any new leases for such activities within the buffer zones of the reserve. Uncontrolled visitation and recreation by outsiders into the area should be monitored, controlled, and possibly developed further with more of an emphasis on nature conservation and education. The ecological threat posed by a new cross island highway that would cut through the northern section of the reserve must be stopped. Efforts must be made to hold further discussions with the Council for Economic Planning and Development (CEPD), Council of Agriculture and TFB to fully explain the importance of keeping the reserve intact. The issue should also be made public so that people are aware of the situation. Future emphasis must be placed on making the public, as well as government officials, aware that conservation and economic development are not opposing forces, but that conservation is a component of normal quality control legislation that should be part of healthy economic growth and planning.

11. Establish and present to the government a clear and concise definition of a buffer zone

The concept of a buffer zone as presented in the main text of this strategy should be legally recognized by incorporation into the official terminology of forest legislation for Taiwan. It should be emphasized that this term need not imply any greater restrictions than are currently placed on national forest land in Taiwan. The term simply would apply to national forestland that is adjacent to a preserve, and has been

recognized as an important buffer area by those in charge of managing the reserve. Officially recognized buffer areas would then be national forest lands that are managed in accordance with the management strategy of the reserve. Any activities allowed within a buffer zone should not impinge upon the reserve in any detrimental way. Thus, official recognition of buffer zones would give certain forested areas different management priorities, though not necessarily any greater legal restrictions.

12. Monitor the management of the western buffer zone area by TFB

Because the western buffer zone area is not within the current boundaries of the reserve, TFB has its own management strategy for this area. Officials of TFB have already stated that because this area is recognized as an important buffer area to the Tawu Mountain Nature Reserve, they will watch it closely and manage it in accordance with protection standards for the reserve itself. The Scientific Advisory Group should watch this area carefully and work with officials of TFB in helping them to understand what might or might not be in the best interests of preserving the ecological integrity of the reserve.

13. Incorporate two southern forest blocks into the reserve

As discussed in the text of this strategy, two forest blocks on the southern perimeter of the Tawu Mountain Nature Reserve (blocks 36 and 37) are currently national forest land which is adjacent to both a military installation and a very small forest reserve. Attempts should be made at bringing these two small forest blocks into the main body of the reserve in order to round out that southern boundary, and to create a

continuous forest block that will help assure protection of the small Tawu Taiwan Amentotaxus Nature Reserve.

14. Conduct surveys into northern buffer zone

Survey efforts must be made into the more rugged northern buffer zone region in order to gather some baseline inventory data on plant and animal species, and to assess illegal use of the area by hunters and visitors. These data will be used to assess the degree of monitoring required by this area, and to put together a report that will be helpful in bringing this area into reserve status. It is assumed that because of the isolation and ruggedness of the area, there will be no severe threats to this forest in the short term. However, this northern area should be carefully watched while attempts are made to incorporate it as part of the Tawu Mountain Nature Reserve. Any illegal activities or poor management practices in this area should be reported to TFB and the Tawu Mountain Administrative Committee.

15. Clarify the laws regarding recreational and/or scientific activities within the reserve

In the wording of the act designating nature reserves, there is no restriction placed on human visitation, only on alteration of the environment. It is assumed that alteration of the environment was meant to mean large scale activities such as timbering, industry, or agriculture. However, human visitation, especially such activities as overnight camping, campfires, etc., is also alteration of the environment and needs to be clearly defined by the appropriate government agency. Due to the fact that some areas of the reserve, such as Little Ghost Lake,

have high visitation rates, we need to investigate the possibility of monitoring and controlling visitation in some areas. Such clarification will also be needed for other areas in the reserve which are not yet known to the public, but could potentially be utilized in the future for nature tourism. Rules regarding scientific research should also be clarified. Basic research that fits into the recommendations of this management strategy should be encouraged. Research that involves simply the collection of plant or animal specimens should be forbidden.

16. Investigate the current level of recreational use of the reserve

Attempts must be made to fully understand the impact of uncontrolled visitation to certain areas of the reserve and buffer zones, and whether or not such visitation should be controlled or further developed. Periodic trips into these areas must be made in order to conduct surveys. These surveys should obtain figures indicating: a) numbers of individuals using particular areas, b) what areas are of greatest interest and why, c) what are the reasons that people come to particular areas, d) how long do they stay, e) what do they do when they are in the areas, and f) on what days and months do people prefer to visit the areas. It would also be useful to ask how people that visit particular areas would feel about regulations for more restricted use, and about potential development of the area that incorporates such things as environmental education, camping, and nature trails.

17. Develop a set of informative posters/brochures for the reserve

An informative, colorful set of posters and brochures should be developed early in the first year for Tawu Mountain Nature Reserve. The

brochures should describe the beauty and uniqueness of the area as well as its importance to Taiwan. These educational materials should be sent to schools in the area, to central, provincial, and local government officials, and should be available at the various information centers in the villages.

18. Organize talks/slide shows at schools and village councils

It is important in the first year to create as much public awareness as possible, particularly in local areas, about the uniqueness and benefits of the Tawu Mountain Nature Reserve. Talks and slide presentations should be given by local officials, members of the Tawu Mountain Scientific Advisory Group, and the newly appointed information officers. These talks will also serve to establish a foundation for an ongoing environmental education program.

19. Build small guard station/checkpoints at major access points

A simply designed and inexpensive guard station should be visibly constructed at major access routes into the reserve, at least one for each watershed area. A design for such a guard house used in an African park is shown in Appendix V. In addition to being a guard station and checkpoint, this building, with an appropriate sign, will serve as a visible reminder of the status of the reserve even when no forest guards are stationed there. However, on certain days, particularly during the dry season hunting months, these checkpoints should be visibly manned and all activity in the area recorded.

20. Build small information centers in major villages near reserve

Simple and inexpensive information centers, in the form of open-air kiosk type structures, should be constructed in several villages near the reserve. These structures will serve to explain the Tawu Mountain Nature Reserve and its potential benefits to the inhabitants of the area and to Taiwan in general. These centers will be checked and maintained by the information officer. There should be a visitor check-in book that lists where people have come from and what their opinions on the reserve are.

21. Continue basic inventory research

22. Expand basic research to investigate baseline abundance data

Although initial surveys were conducted in the Tawu Mountain Nature Reserve, they were not comprehensive. Good baseline inventory data is needed for the reserve so that we are fully aware of the resources that are contained within the area, and so that scientists can begin a monitoring program on some key plant and animal species. The presence of the clouded leopard within the Tawu Mountain Nature Reserve is still uncertain and further inventory work should emphasize searching for signs of this cat.

Most of the emphasis in the initial surveys was on mammals, with secondary emphasis on birds. Further inventory work needs to be conducted on the full range of vertebrates - birds, reptiles, amphibians, and fish. In addition, preliminary estimates of particular species

densities and biomass would be very useful for future research and management.

23. Identify sites to set up permanent environmental monitoring stations

Taiwan is in the midst of an environmental crisis regarding key resources such as air and water. Yet there appears to be little comprehensive monitoring research being conducted on the island. Baseline data on parameters such as air and water quality, floristic associations and relative abundance of key "indicator" vertebrates needs to be carried out. Such data will help to indicate any environmental degradation that is occurring within the reserve itself, and will serve as baseline data for comparisons with other areas of the island.

24. Conduct a first year evaluation by Tawu Mountain Scientific Advisory Group

At the end of the first year, the Tawu Mountain Scientific Advisory Group should meet and evaluate progress in implementing the management and conservation strategy. Reasons for not having carried out particular measures should be clarified and any unanticipated obstacles, delays, or developments should be discussed and dealt with. Priorities for the next year should be discussed. A full report regarding progress and future recommendations should be submitted to the Tawu Mountain Administrative Committee.

B. Years 2-3

1. Set up a Tawu Mountain Nature Reserve manager position

This position would replace that of the information officer and would entail a salary as well as greater responsibilities and duties. More of the responsibility of organization and oversight should be shifted from the Tawu Mountain Scientific Advisory Group to the reserve manager who will, for the first year, report monthly to the Scientific Advisory Group chairperson. Along with other duties set forth by the Tawu Mountain Scientific Advisory Group, it will be the responsibility of the reserve manager to work with and monitor the poaching patrols, interact with local and provincial officials, develop good relations with the aborigines and local Han Chinese in the area, and give talks at schools and local communities regarding Tawu Mountain Nature Reserve and conservation.

The reserve manager should be selected carefully because he will be the main person representing the Tawu Mountain Nature Reserve. His personality should be suitable to interacting well with both local people and government officials.

2. Field workshop to train guards in basic monitoring work

A workshop will be held so that appropriate personnel, such as the forest guards, who are involved in the protection and management of the Tawu Mountain Nature Reserve can be trained in data collection within the reserve. Eventually they should be capable of collecting data both at the permanent monitoring stations and while conducting patrols within

the reserve. Techniques such as track stations, track and spoor identification, collection and preservation of fecal material, and air and water quality assessment will be reviewed. Materials in the form of detailed but simplified handouts/checklists should be prepared and possibly compiled into a small field manual.

3. Classroom/field workshop for teachers/local officials in area

As a follow-up to the lectures and environmental awareness programs carried out during the first year, at least one detailed classroom and field workshop should be arranged for teachers and local officials in the Taitung area. Such a workshop will promote conservation and environmental awareness, with the Tawu Mountain Nature Reserve as the major focus. The benefits to the local people, both short and long term, should be stressed.

4. Increase guards and poaching patrols

The number of guards and schedule of poaching patrols will, in part, be determined by the success of the poaching patrol initiated during the first year. A more permanent and regular system of patrolling activities should be established during this time. There should still be periodic multi-day patrols within the reserve, and occasional raids by large numbers of guards and/or police officers during the peak of hunting season in order to confiscate traps and severely curtail the activity of hunters. The major emphasis for the management and conservation of Tawu Mountain Nature Reserve during these first years should always be on trying to eliminate, or at least severely restrict, hunting in the Tawu Mountain Nature Reserve. Therefore, whatever

funds are necessary toward this end should be made available. Areas within the reserve used heavily for recreational purposes, such as Little Ghost Lake, should also be closely monitored.

5. Build backcountry guard and monitoring stations

6. More permanent guard stations/checkpoints at major entrances

In conjunction with the more regular system and schedule of patrolling mentioned previously, more guard stations should be set up at other major access routes, along main travel routes within the interior, and at areas used for recreation. Larger, overnight backcountry guard stations should be built along important patrolling routes or in areas of heavy human use. A potential design for such an overnight station is shown in Appendix VI. If possible, such stations can be situated at an environmental monitoring site so that they can be used by patrols as well as by individuals involved in monitoring efforts.

The original stations situated at the most heavily used access points should be made into larger, more permanent structures if it is felt that these stations have been beneficial and that a larger structure would be more useful.

7. Continue to check on major hunting families who use Tawu Mountain area

Periodic visits should be made by the reserve manager to the families or individuals who claim to have hunting rights within the boundaries of the Tawu Mountain Nature Reserve. Their help should always be welcomed, but they should be made aware that their activities

are not going unnoticed. Individuals who ignore warnings and are known to poach regularly in the reserve should be reported to and visited by the police.

8. Expand at least one information center into a visitor center

At least one of the small open-air kiosk information centers should be expanded and developed into a more permanent visitor center in a village that appears to be critically situated in relation to activities in the reserve. More educational materials and possibly slide shows can be developed at this time to be used at the center. School groups or other special groups can be invited to the center for environmental education programs. Development and maintenance of the center will be one of the primary responsibilities of the reserve manager. A simple, inexpensive design for a small visitor center is shown in Appendix VII. If a design such as this is used initially, it can be expanded into a larger, more permanent structure when feasible.

9. Control and possibly develop visitation to recreational areas

If the law permits, and both the Tawu Mountain Administrative Committee and the Scientific Advisory Group agree that controlled recreational use of certain area within the reserve and its buffer zones can be beneficial, than efforts should be made to control and possibly develop such recreational use. Well marked trails, informative signs, and allocated camp sites can be used to control and restrict visitor access while allowing people a more enjoyable and educational experience in and around the reserve.

However, all activities within protected zones of the reserve must be carefully monitored and should have minimal impact on the natural environment. Initially, all visitation and recreational use should be restricted primarily to outlying or buffer areas of the reserve. Hiking or excursions deep within the core area of the sanctuary should not be allowed.

10. Legal recognition of buffer zone areas

The proposal for official recognition of buffer zone areas around reserves should have been presented to the government during the first year of this strategy. If it has not yet been acted upon by the second year, there should be renewed efforts to incorporate the concept of buffer zone into official forest legislation. This is important for the future management and protection of the Tawu Mountain Nature Reserve.

11. Incorporate northern buffer zone into the reserve

The northern buffer zone area should already have been initially surveyed and suggested for reserve status. In any report to the government, it must be emphasized how this region encompasses additional water catchment areas and is a continuation of the forests along the Central Mountain Range that comprise the Tawu Mountain Nature Reserve. Protection of this area would enhance the protection of the core area of Tawu Mountain Nature Reserve, and would further enhance the conservation goals of this strategy. Whether or not this area should be designated a separate reserve or attached to the Tawu Mountain Nature Reserve is left up to the judgement of the Scientific Advisory Group, which will determine which action would be more

beneficial to the reserve. It is possible that the declaration of this area as a separate reserve would enhance protection. While waiting for this area to officially be brought under reserve status, it must be made certain that it is recognized as an important buffer zone to the reserve.

12. Continue to work with TFB and local government on usage of buffer zones

Discussions should be held periodically with local government officials asking for their assessment of the situation in the buffer zone areas. The Tawu Mountain Committees should work with the local offices to make sure their needs are met for the proper management and protection of the buffer zones. Any new infringements or environmental degradation occurring within the buffer zone areas should be assessed by the scientific advisory group and discussed with TFB. Finances to assist in the management and development of the buffer zone areas should be made available to the local forest district offices when needed. It should be made clear that finances for the buffer zone areas are just as important as finances for protecting the reserve itself.

13. Set up at least two long term monitoring stations

In the initial stages of the plan, at least two relatively accessible monitoring sites, probably in the central Tamali watershed, should be set up. These should be permanent stations, preferably located both along a riverine area and at a high elevation site. Parameters of air and water quality can be measured using relatively simple and inexpensive chemical kits and field equipment. Animal use and relative abundance in the area can be measured using scent and bait stations and by

quantification of spoor along transect lines. Vegetation differences and potential changes in plant associations can be monitored in plots or along transects.

The data collected from these monitoring sites will serve as baseline information for use within Tawu Mountain Nature Reserve and for comparison with other areas outside of the reserve. These data will aid in assessing the relative success of the management plan and in documenting environmental degradation occurring both in Tawu Mountain Nature Reserve and elsewhere on the island.

14. Research inventories - emphasis on relative abundance and diversity

Basic research, in addition to simply monitoring key environmental parameters, should continue to play an important role in the management strategy. Once comprehensive lists of species have been developed, particularly for vertebrates, efforts should be made to assess relative species abundance and possible biomass within different areas of the reserve. This is important for good biological data on some of the endemic species and subspecies, as well as for good baseline data to monitor future changes in particular key species.

15. Develop special student research fund for work in reserve

A special fund should be established to provide graduate students with the opportunity and incentive to conduct scientific research in the Tawu Mountain Nature Reserve. The students can obtain data needed for the management of the reserve as well as for their

own graduate degrees. The research fund can provide students with expense money and a small stipend.

16. Try to visit all areas within reserve - document key areas

17. Continue to document illegal disturbances

By this time, all of the watersheds should have been visited by survey teams and, in most of the areas, penetration deep within the watershed should have been attempted. The purpose of this is so that forest guards can know the reserve area to the fullest extent possible. We must have complete knowledge of illegal use and access deep within the reserve, special scenic areas, and relative abundance patterns of key wildlife species in different areas. Some species which should be focused on include the clouded leopard, black bear, sambar deer, Chinese otter, Hodgson's hawk eagle, and the Maroon oriole. Complete knowledge of the area will also assist the forest guards in establishing new routes or trails for their patrol.

18. Organize a meeting of Tawu Mountain Administrative Committee - second year

19. Evaluation by Tawu Mountain Scientific Advisory Group - second and third years

In both the second and third years the Tawu Mountain Scientific Advisory Group should meet to evaluate progress and problems with the management strategy, and establish new recommendations and priorities for the next year. During the third year a meeting should be held jointly by the Scientific Advisory Group and the Tawu Mountain Administrative

Committee in order to fully update all the members of the Administrative Committee and discuss the progress of the reserve.

C. Years 4-5

1. Conduct fourth year evaluation by Tawu Mountain Administrative Committee

2. Evaluation by Tawu Mountain Scientific Advisory Group - fourth and fifth years

There should be fourth and fifth year meetings by the Tawu Mountain Scientific Advisory Group coordinated with a fourth year meeting by the Tawu Mountain Administrative Committee. These meetings are of particular importance because they will review the success of this management plan and discuss an updated five year management plan for Tawu Mountain Nature Reserve.

3. Update management plan for the Tawu Mountain Nature Reserve

By the fifth year, a complete evaluation of this management plan should be undertaken along with recommendations for the next five years. At this time the Tawu Mountain Scientific Advisory Group should look at both the successes and failures of the original management plan and take steps to reorganize priorities for the reserve accordingly. The major emphasis of the first five years is on protection of the reserve through stopping or severely curtailing hunting, increasing the size of the reserve, and stopping any immediate threats impinging upon the reserve. If these goals have been accomplished to the satisfaction of the committees, then in following years, more of an emphasis can be placed

on education, research, and possibly recreational use. However, the highest priority must always be on maintaining a firm hand in the protection of the integrity of the reserve.

4. Detailed comprehensive research on key wildlife species

Once hunting in the reserve has been curtailed or eliminated, scientists should consider Tawu Mountain Nature Reserve as a perfect area for detailed research on some of Taiwan's key wildlife species such as bears and muntjac. Specialized techniques such as tagging and radiotelemetry can provide information never before obtained regarding the ecology of some key species in Tawu. Information on movement and activity pattern would be of particular importance with some of the larger, more threatened species. Data which would indicate whether individuals move between watersheds or whether they are restricted to certain areas within the reserve would be crucial for evaluating management and protection criteria of certain species.

5. Maintain special student research fund for work in reserve

The student fund for conducting research in the Tawu Mountain Nature Reserve should be evaluated. If this fund has been successfully utilized in both helping the reserve and helping students further their education, then the level of funding should possibly be increased.

6. Guidebook to the Tawu Mountain Nature Reserve

By the fifth year a colorful and informative guidebook should be assembled about the Tawu Mountain Nature Reserve. Such a book should detail the importance of the reserve, the role it has played in

conserving some of the natural heritage and resources of Taiwan, and its importance in the future. The book should be educational as well, containing species checklists and descriptive accounts of many of the beautiful flora and fauna found within the reserve. An example of such a book was put together for Taroko National Park by Teng-Lang Yu (1989).

7. Monitor new northern reserve area

By this time, the original buffer area to the north should be established as a reserve, and should be undergoing regular monitoring efforts. Such efforts should include anti-poaching patrols, environmental monitoring, and assessment of baseline wildlife data. Because certain parts of this area contain sites of potential recreational importance, these areas in particular should be closely watched and developed in accordance with other recreational areas in the reserve.

8. Monitor and assess remaining buffer zone areas around the reserve

Any areas remaining as buffer zones should be continually monitored for management and encroachment. Yearly evaluations should be made by the Tawu Mountain Scientific Advisory Group on whether it is in the best interests of the reserve for particular pieces of forest to remain as buffer zones, or whether they should be incorporated into the reserve. Any potential change in status should first be discussed with TFB.

9. Increase long term monitoring stations in different watersheds

By the fourth year, the success of the original monitoring stations should be assessed and, if appropriate, these stations should be set up with improved and more permanent facilities. If such stations have been successful, additional stations can be set up in other watersheds of the reserve. Eventually each watershed within the reserve should be monitored on a regular basis. Such stations will accumulate ecological data in such a way that has never before been done in Taiwan. There should be certain key people trained in maintaining and collecting the data from these sites.

10. Formalize position and responsibilities of the reserve manager

By the fourth year the position of reserve manager should be formalized as a permanent position, if this has not already been done. The reserve manager should be playing a key role in the planning and management of the reserve and should, by this time, be the key link between the committees in Taipei and local administration and enforcement in the Tawu Mountain area. An office or headquarter should be established for him/her, possibly as part of the visitor center.

11. Evaluate need for hiring an assistant to the reserve manager

If the position of reserve manager has been successful, then the level of work required by this individual should have increased substantially by this time. If both the protection of the reserve and the educational programs are going well, then it is possible that an assistant

to the reserve manager should be hired in order to maintain and expand all the programs.

12. Evaluate wildlife trade and hunter attitudes around reserve

A wildlife trade survey, similar to that conducted by Wang (1986) and Wang and Lin (1987), should be undertaken in the southern Taiwan region. This survey should re-evaluate the ongoing trade and demand for wildlife, as well as current hunters' attitudes towards both hunting and restrictions placed on the Tawu Mountain Nature Reserve. Such data will help to evaluate both the possible effectiveness of the anti-poaching patrols and the degree of effort needed in the future. The new Wildlife Conservation Law should help to curtail hunting activities in the Tawu Mountain area.

13. Maintain and possibly increase forest patrols

Constant evaluation of the effectiveness of the anti-poaching patrols is needed to determine the ongoing levels of effort that should be expended each year. Such evaluation should be based upon numbers of traps destroyed and/or confiscated, numbers of hunters observed in the area, levels of demand and trade in wildlife in the surrounding towns and cities, hunters' perceptions and attitudes, and the opinions of the local forestry officials and forest guards. A regular schedule of forest patrols must be maintained at all times. If illegal hunting and trade in wildlife in Tawu Mountain and its surrounding area has not been virtually eliminated or severely curtailed by this time, then additional funds must be made available for increased efforts to stop this activity. This is

potentially the greatest threat to the reserve and must be eliminated at all costs.

14. Increase the function and capabilities of the visitor and information centers

Use and impact of the visitor and information centers should be evaluated. The information and displays within the visitor center in particular should be continually rotated, updated and periodically changed. The capabilities and functions of both the information and visitor centers should be expanded according to their use and demand. At the visitor center, facilities should be available for shows for school or special interest groups. Guidebooks, checklists, posters, and possibly local crafts can be sold at the center.

15. Further develop trails and facilities at key recreational areas

If the concept and practice of limited recreational use of the Tawu Mountain Nature Reserve has been successful, such activities can possibly be expanded to include overnight or several day excursions into key scenic areas. At areas which show heavy use with no obvious environmental degradation, additional trails and visitor facilities may be considered. Again, it must be emphasized that the purpose of this reserve is not for recreation, and that recreational use of areas of the reserve should be considered only when it does not damage or interfere with the natural environment.

16. Public awareness campaign on accomplishments of Tawu Mountain Nature Reserve

At this time the public should be made more fully aware of the Tawu Mountain Nature Reserve. A television documentary about the reserve would be extremely useful, as well as colorful newspaper and magazine articles. Making Tawu Mountain Nature Reserve known and, to some extent, popular with the general public and government officials can go a long way toward curtailing any future development plans which could infringe upon or threaten the reserve. Reporters and television people can be invited on a guided tour of the reserve and shown its accomplishments, scenic beauty, and biological importance.

Public awareness about the reserve should have already been developed, but on a more regional level. Now, the emphasis can be on a more national level which also stresses the results of the implementation of a comprehensive management strategy. People should be made aware how the implementation of a proper management strategy is beneficial not only to the reserve, but to the local people, and to Taiwan as a whole.

These management criteria set down in this strategy for the first 5 years are guidelines, based on current and projected needs of the area. Management activities for different years are based first on securing and maintaining protection for the reserve as it currently exists; second, extending the boundaries and protection of the reserve; and third, on utilizing the reserve for educational and possibly limited recreational use. It will be up to Tawu Mountain Administrative Committee and the Scientific Advisory Group to see that these objectives are carried out to the fullest extent possible. The Tawu Mountain Scientific Advisory Group should be continually evaluating progress and possibly readjusting priorities and yearly management activities. The Tawu Mountain Administrative Committee will have final authorization on actions regarding the Tawu Mountain Nature Reserve and should help in matters regarding legal decisions and financial needs.

XI. Projected Budget for the Five Year Management Plan for Tawu Mountain Nature Reserve

Year 1 presents specific budget needs. For subsequent years, the items below represent potential needs which must be reviewed and updated by the Tawu Mountain Scientific Advisory Group annually. These figures are in NT dollars and are, at this point, approximations only. However, the overall budget request for the first year, according to the items specified below, is approximately NT$5,742,000.

A. Year 1

I. Manpower/management plan implementation/education

1. Scientific Advisory Group expenses ---------- $2,500,000
   - Continued surveys and research
   - On site visits to check progress

2. Management plan workshop ---------- $ 150,000
   - Expenses for participants
   - Cost of printing materials

3. Forest guards for patrol (min. 20) ---------- $ 30,000
   - Salary - To be provided by TFB
   - Uniforms (special patches, hats, etc.)

4. Part time forest guards/guides for special patrols (5-10 persons) ---------- $ 600,000
   - Wages
   - Expenses

5. Local information officer ---------- $ 250,000

Stipend/Expenses

Uniform

6. Lectures at local schools/village councils -------- $ 80,000

Expenses

Hand-out materials

Cost of developing slide shows

II. Infrastructure and associated costs

7. Guard stations/checkpoints ---------- $ 700,000

8. Information centers (4-5) ---------- $ 300,000

Displays

Posters

Brochures

9. Signs for reserve ---------- $ 200,000

III. Equipment

10. Scientific monitoring equipment ---------- $ 200,000

Air/water/soil quality testing kits

Accessory survey materials

11. Slide projector and screen ---------- $ 60,000

12. Walkie Talkies for forest guard patrols ---------- $ 150,000

IV. Contingency fund (10%) ---------- $ 522,000

To help local forest offices manage and patrol buffer zone areas. For unexpected maintenance costs and other expenses needed to implement the management plan.

Total---------- **$5,742,000**

B. Years 2-3

I. Manpower/management plan implementation/education

1. Scientific advisory group expenses

2. Research fund for student research in reserve

3. Field workshop for training guards in monitoring

Expenses for participants

Printing materials for hand-outs

4. Classroom/field workshop

Expenses for participants

Hand-out materials

5. Forest guards for patrol - salaries provided by TFB

6. Part time forest guards/guides for special patrol

Wages/Expenses

7. Reserve manager

Salary/Expenses

II. Infrastructure and associated costs

8. Guard stations/checkpoints

Expansion of additional stations/repairs

9. Information/visitor center

Build new visitor center

Expand and/or maintain existing information centers

Budget for changing displays, maintenance of center

New and additional posters and brochures for area

10. New or replacement signs for reserve

11. Recreational area development - signs, brochures, maintenance

12. Cost of setting up monitoring stations (hut/storage shed)

III. Equipment

13. Improved and more sophisticated monitoring equipment (i.e. equipment for weather station, etc.)

14. Equipment repair and replacement

15. Accessory scientific equipment

IV. Contingency fund

Help local forest offices with management and patrol of buffer zones. For unexpected expenses of management plan.

C. Years 4-5

I. Manpower/management plan implementation/education

1. Scientific advisory group expenses

2. Increased research fund for students

3. Forest guards for patrol - salaries

4. Part time forest guards/guides for special patrols - wages

5. Reserve manager - salary/expenses

6. Possible assistant manager position - wages/expenses

7. Updated survey on game shops/hunters' attitudes in area

8. Development of detailed guidebook for Tawu Mountain Nature Reserve

9. Expenses for public awareness campaign

II. Infrastructure and associated costs

10. Environmental monitoring stations

Increase number of stations

Repair and maintenance of old stations

11. Guard stations/checkpoints

Expand and improve important stations

Maintenance and repair

12. Information/visitor center

Maintenance and improvements

Budget for new displays, school group visitation, etc.

13. Recreational area development

Signs, trails, camp sites

III. Equipment

14. Additional environmental monitoring equipment

15. Additional research equipment

IV. Contingency fund

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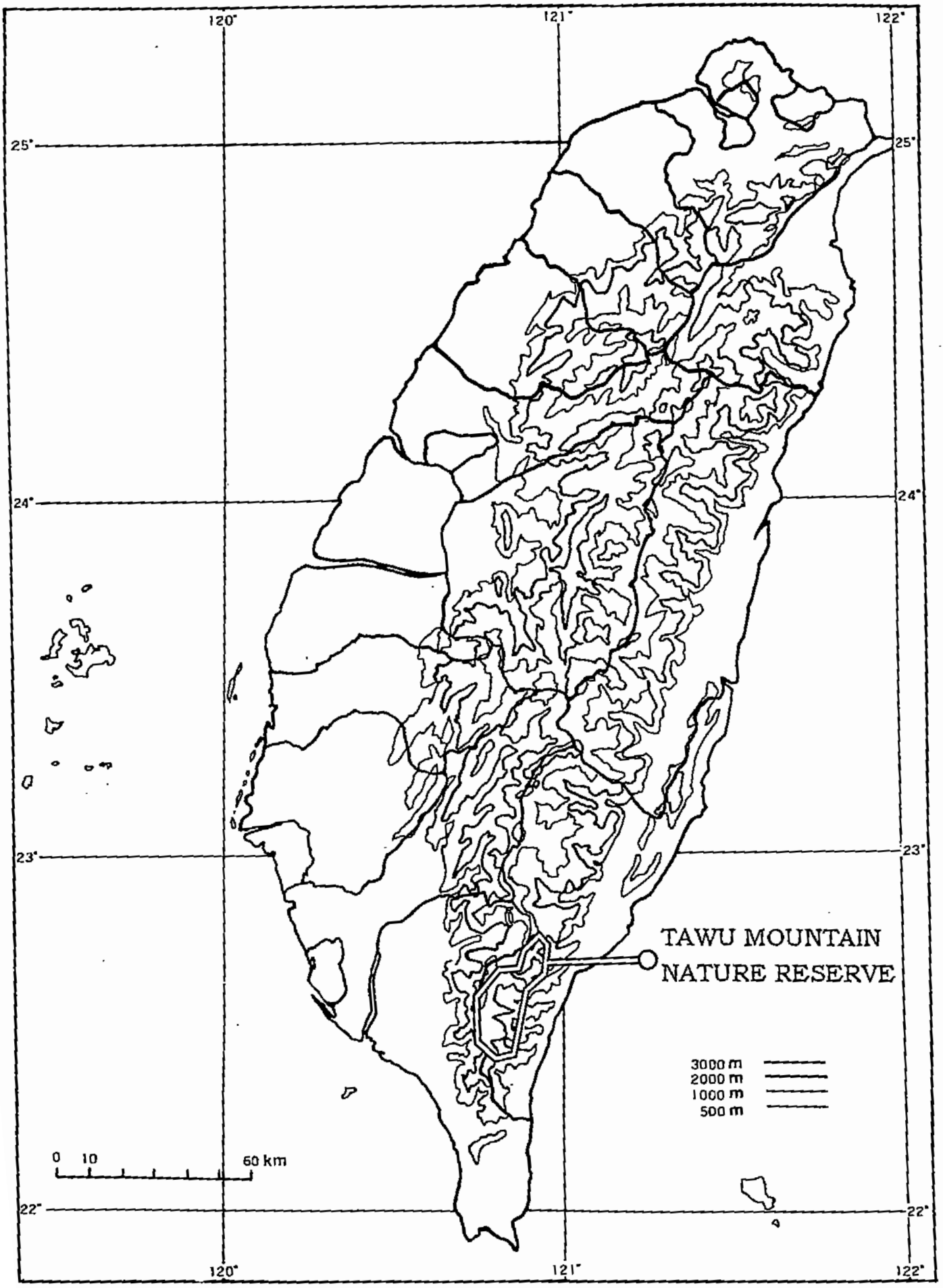


Figure 1. Topography of Taiwan.

Figure 2. Vegetation map of Tawu Mountain Nature Reserve.

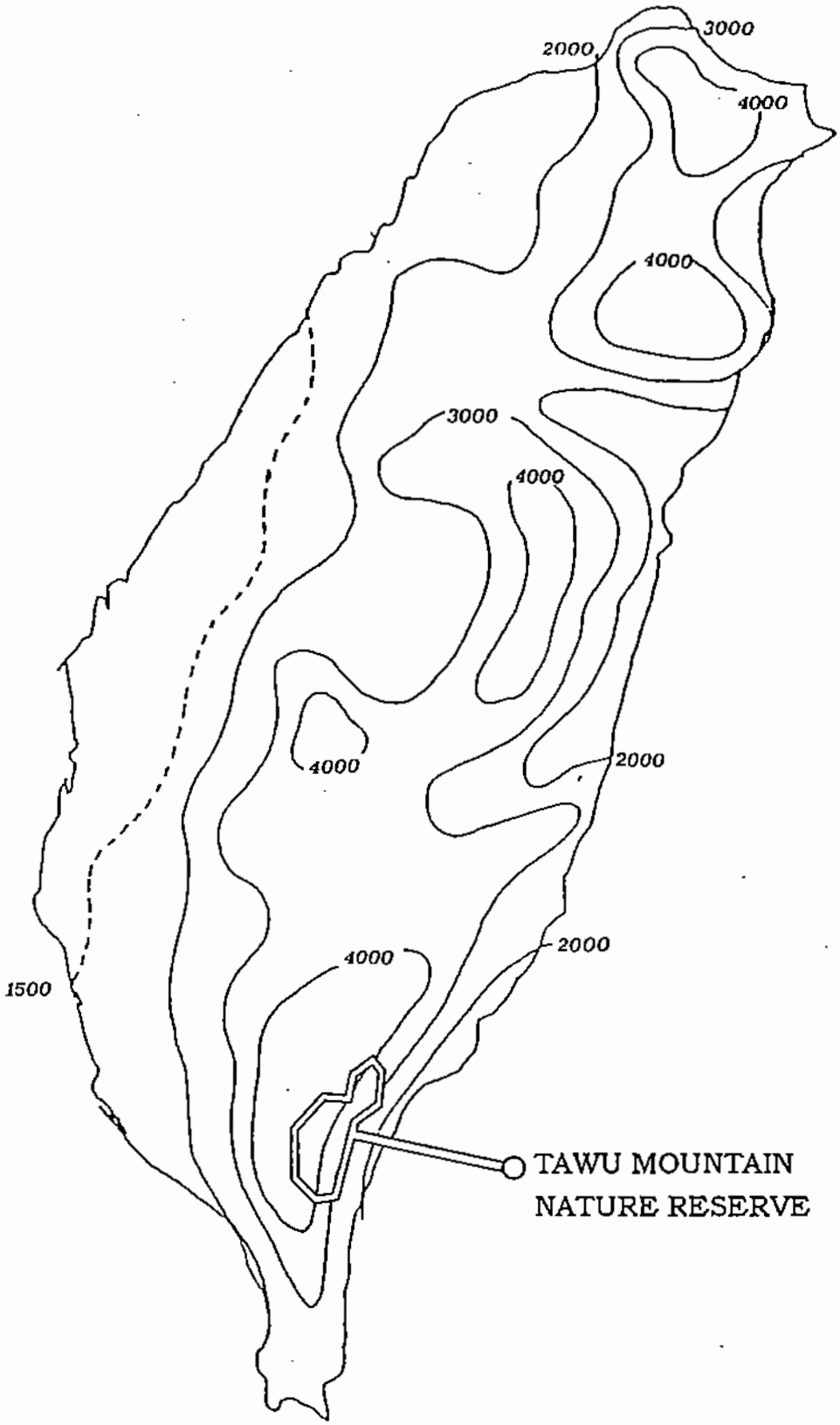


Figure 3. Annual rainfall pattern of Taiwan (mm).

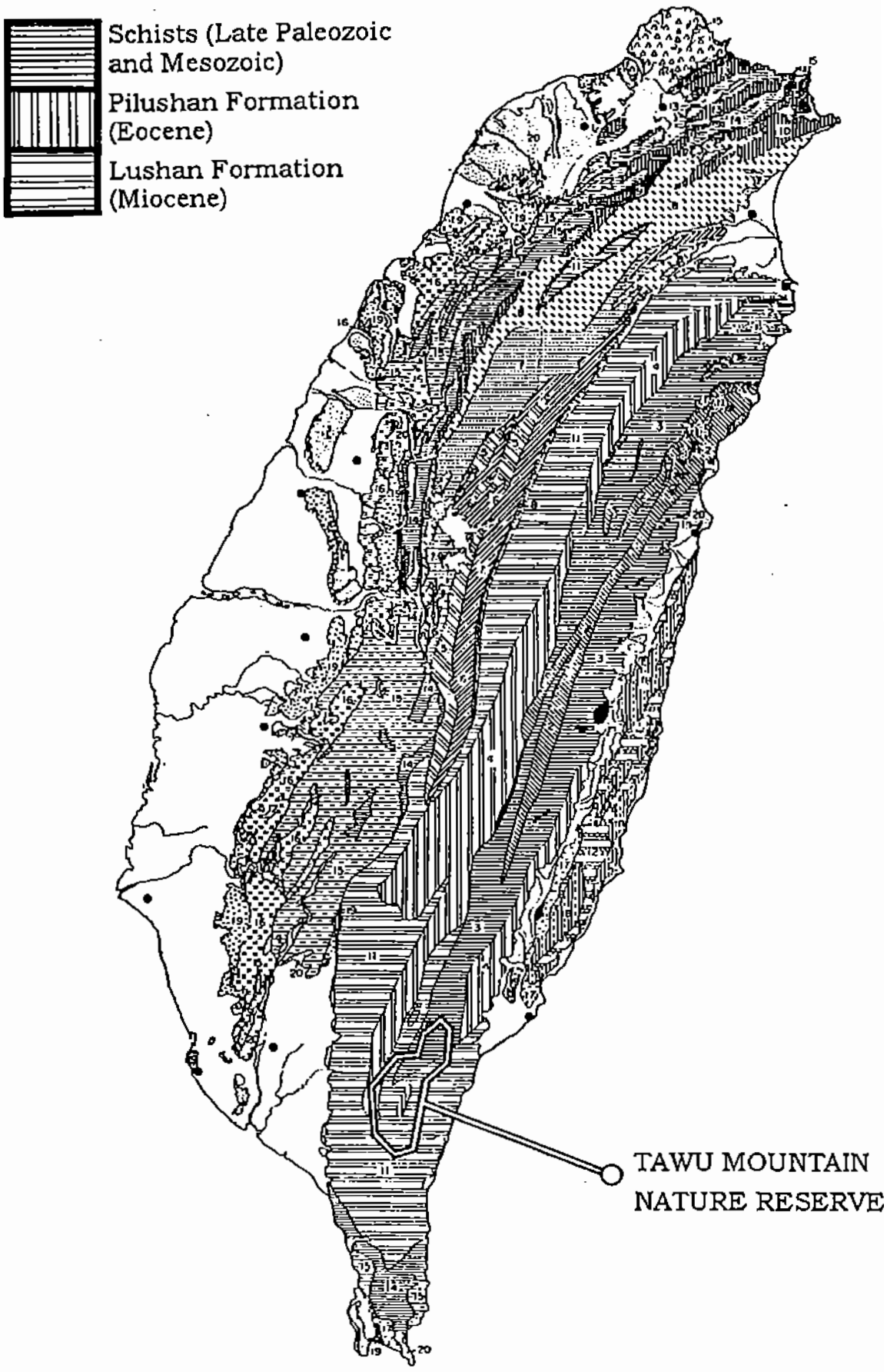


Figure 4. Geological map of Taiwan.

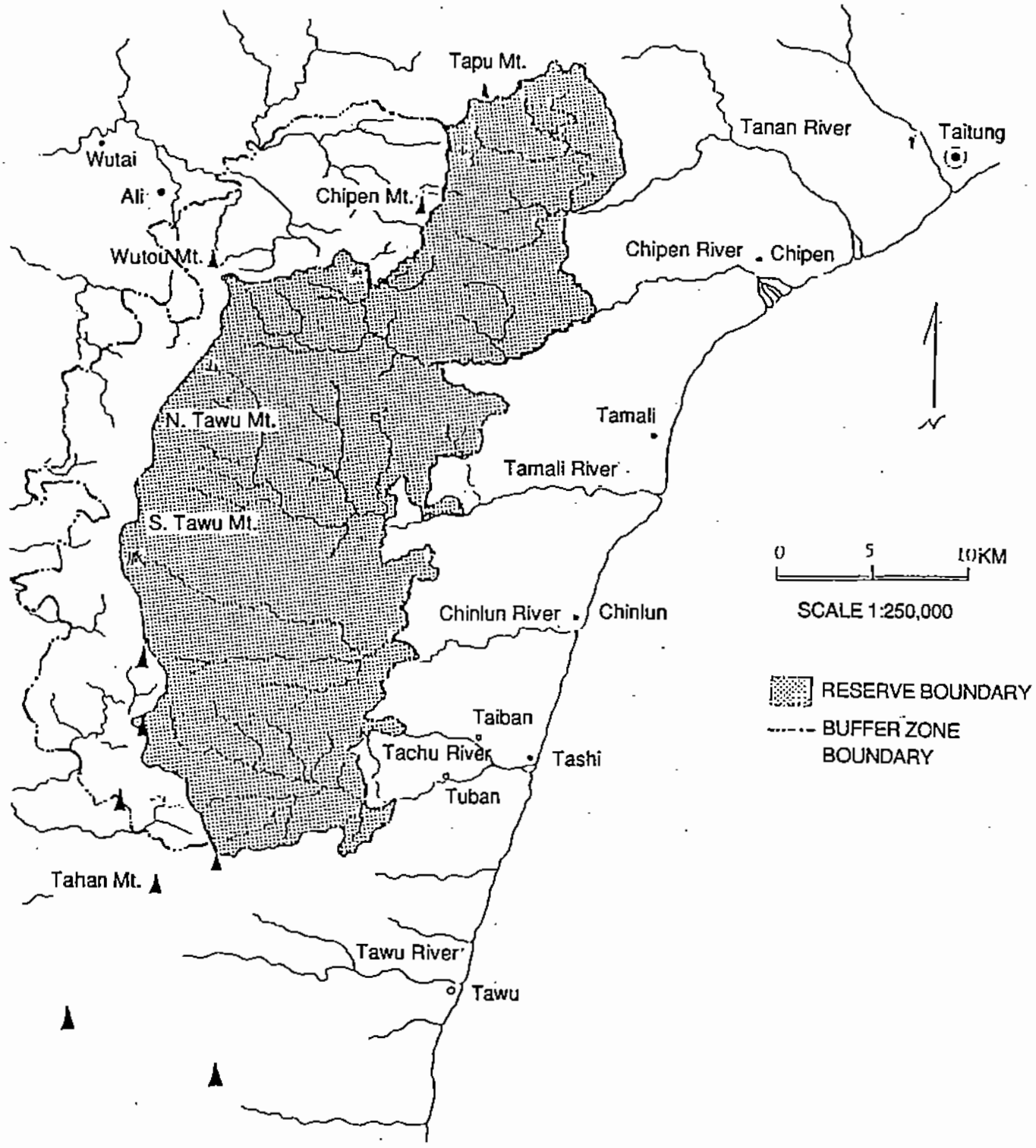


Figure 5. Boundaries of Tawu Mountain Nature Reserve and western buffer zone.

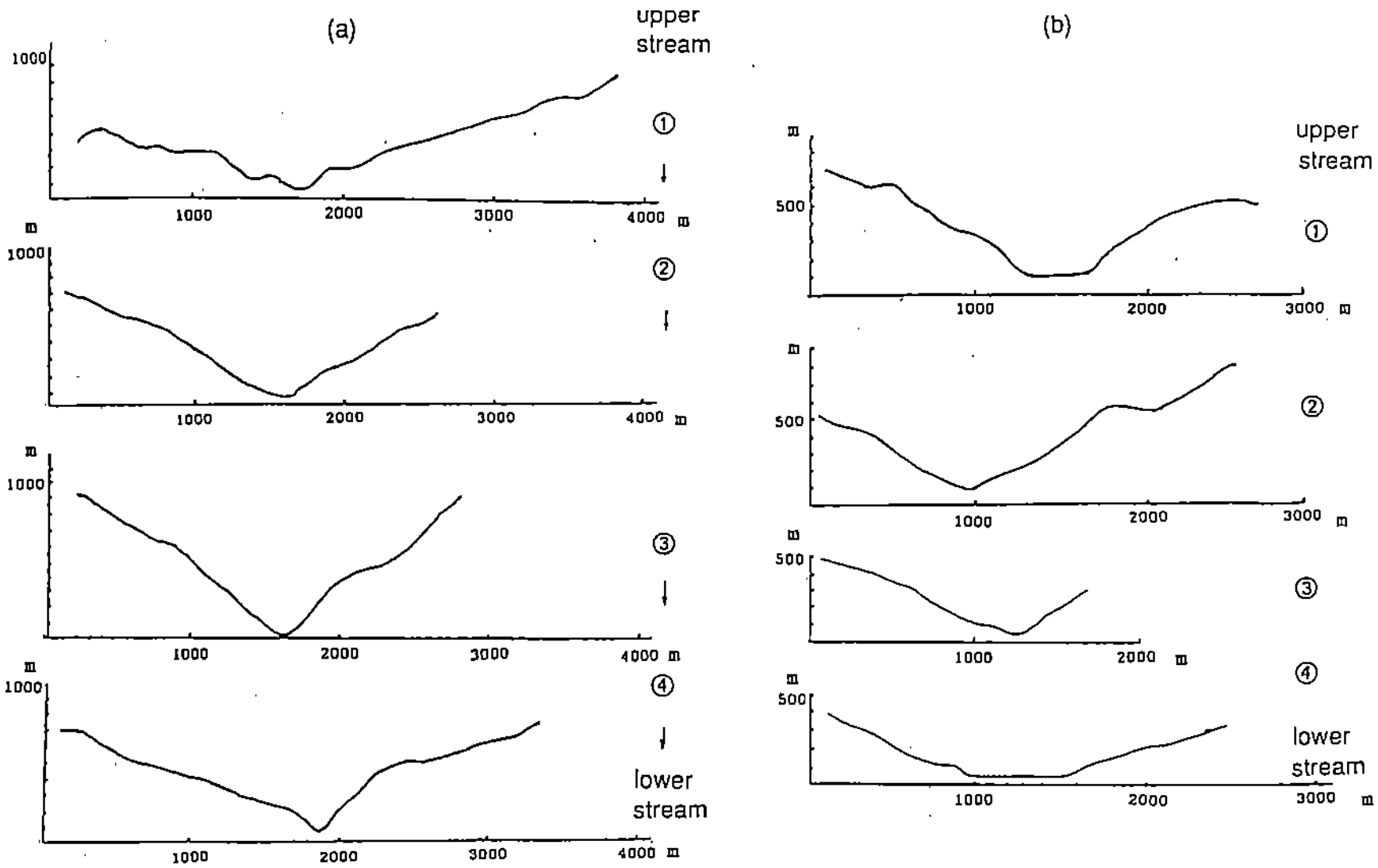


Figure 6. Diagrammatic cross sections of (a) Chipen and (b) Tamali waterways.

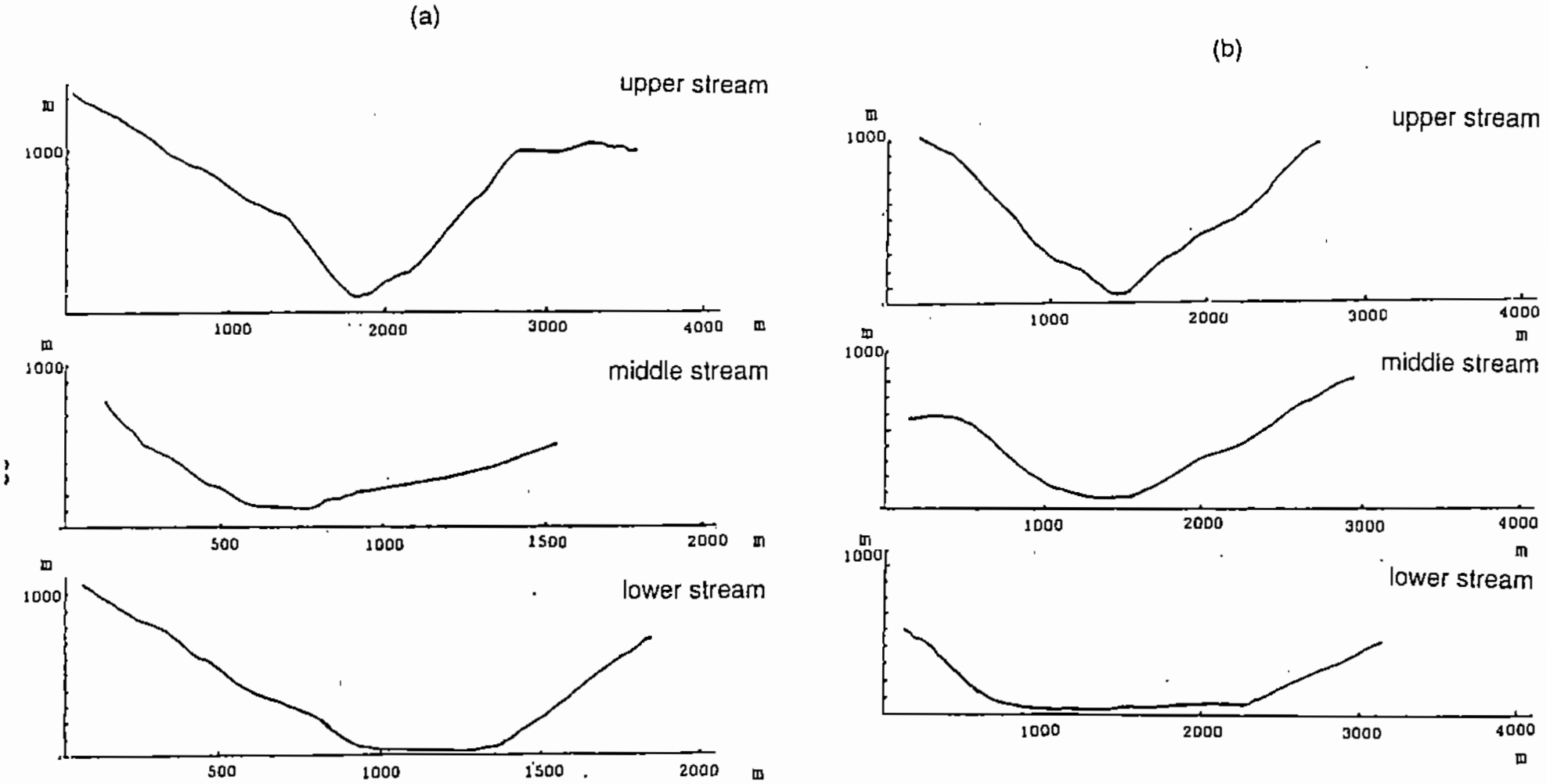


Figure 7. Diagrammatic cross sections of (a) Chinlun and (b) Tachu waterways.

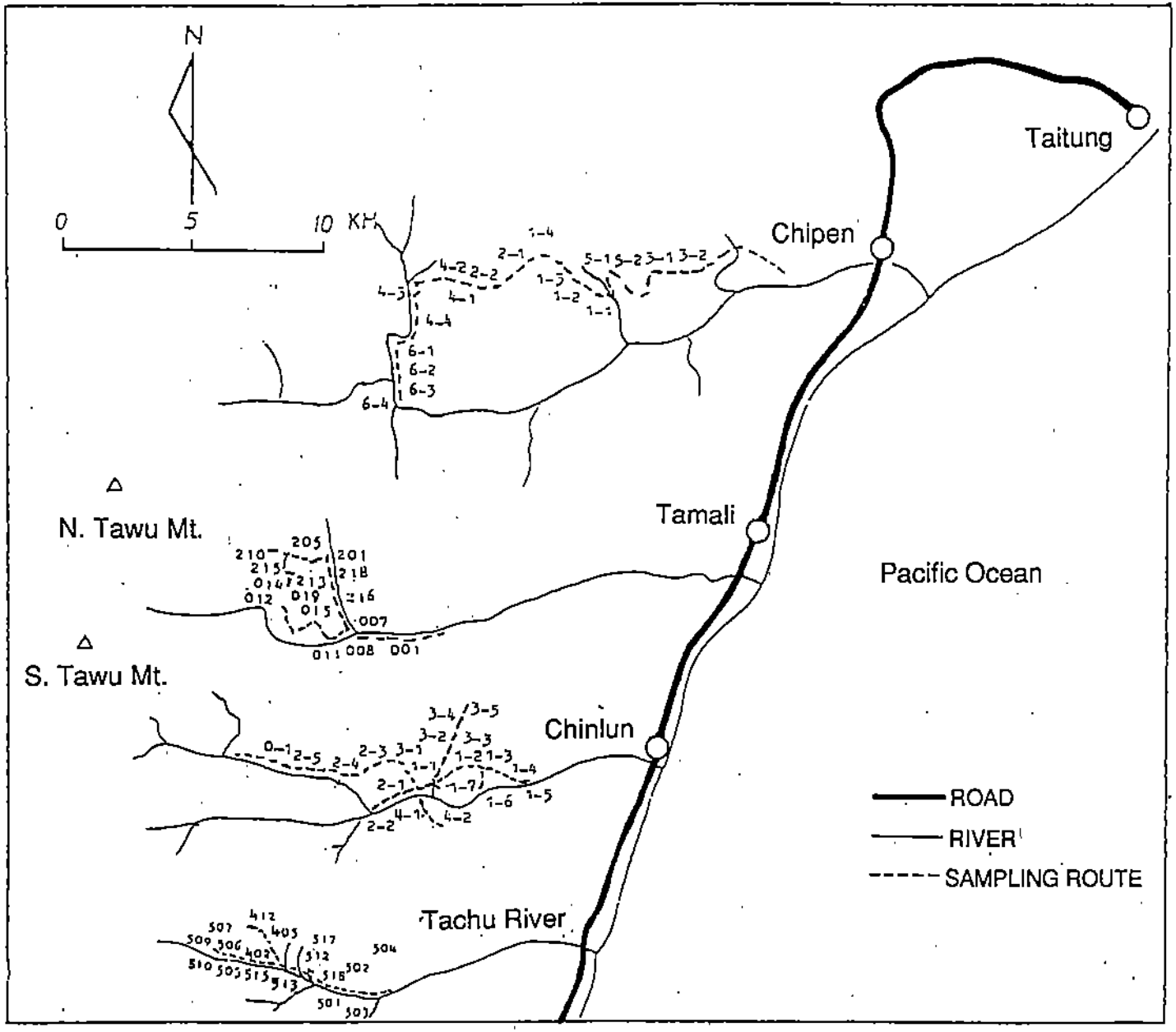


Figure 8. Vegetation sampling plots (below 1000 m elevation) in Tawu Mountain Nature Reserve.

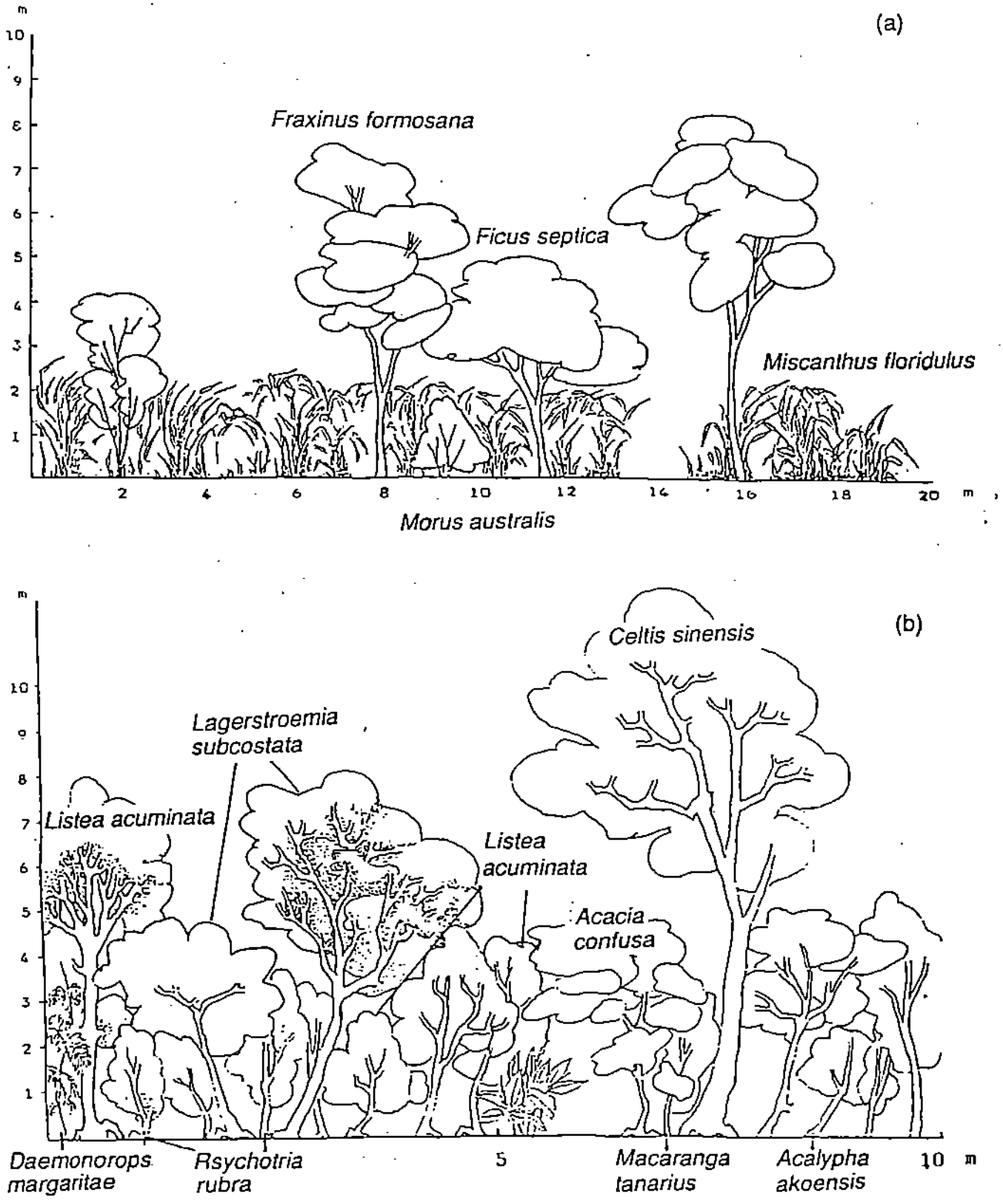


Figure 9. Tree species at (a) 300 m and (b) 680-720 m elevation along Tamali and Tachu waterways.

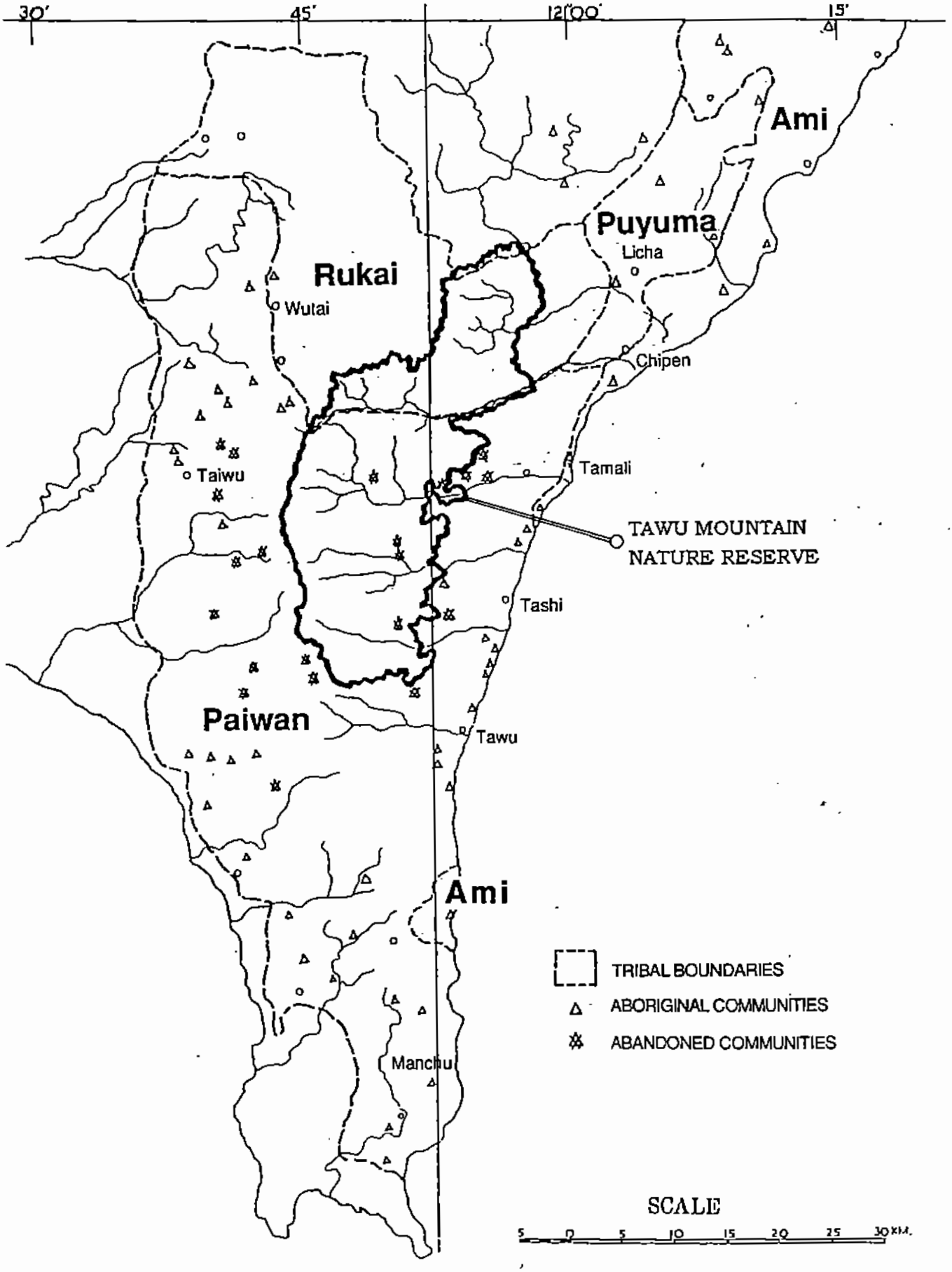


Figure 10. Map of aboriginal settlements (1965).

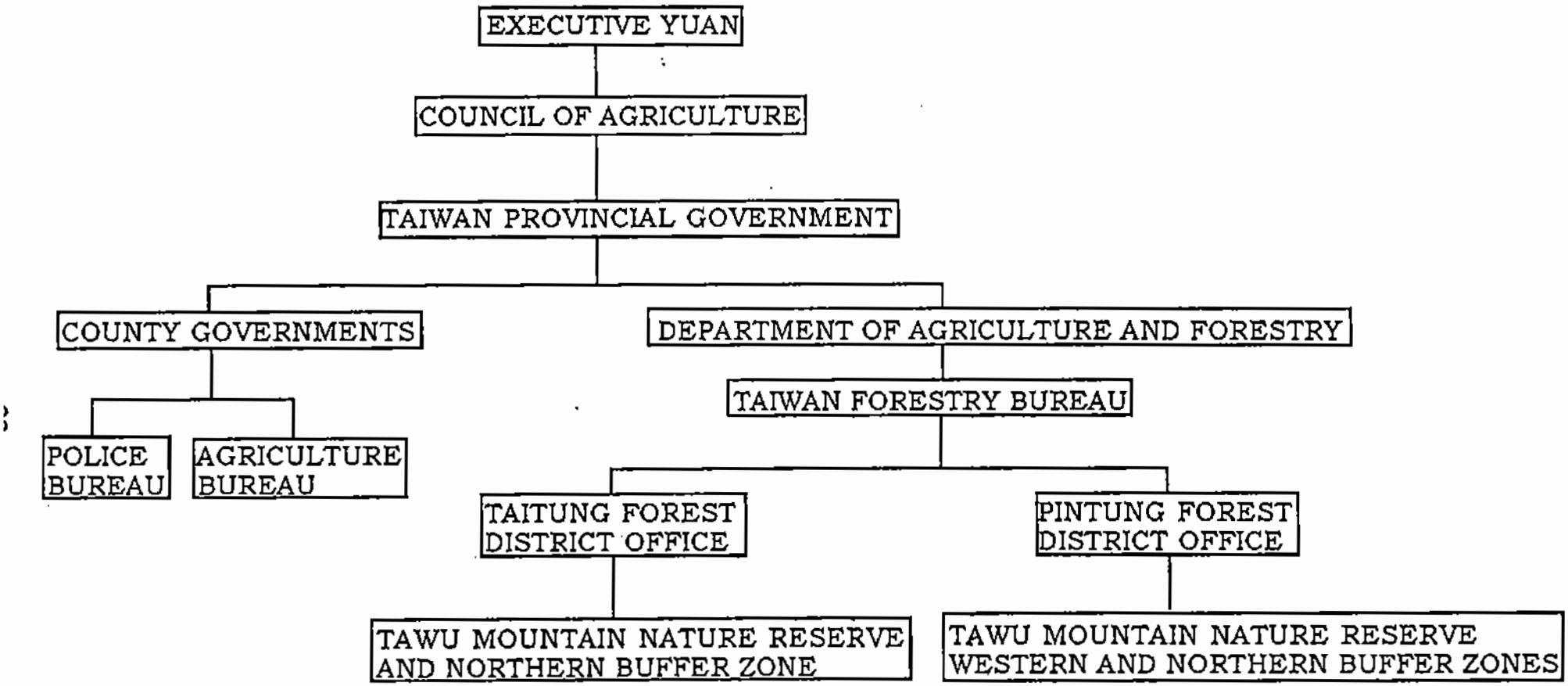


Figure 11. Chain of command for protection of Tawu Mountain Nature Reserve.

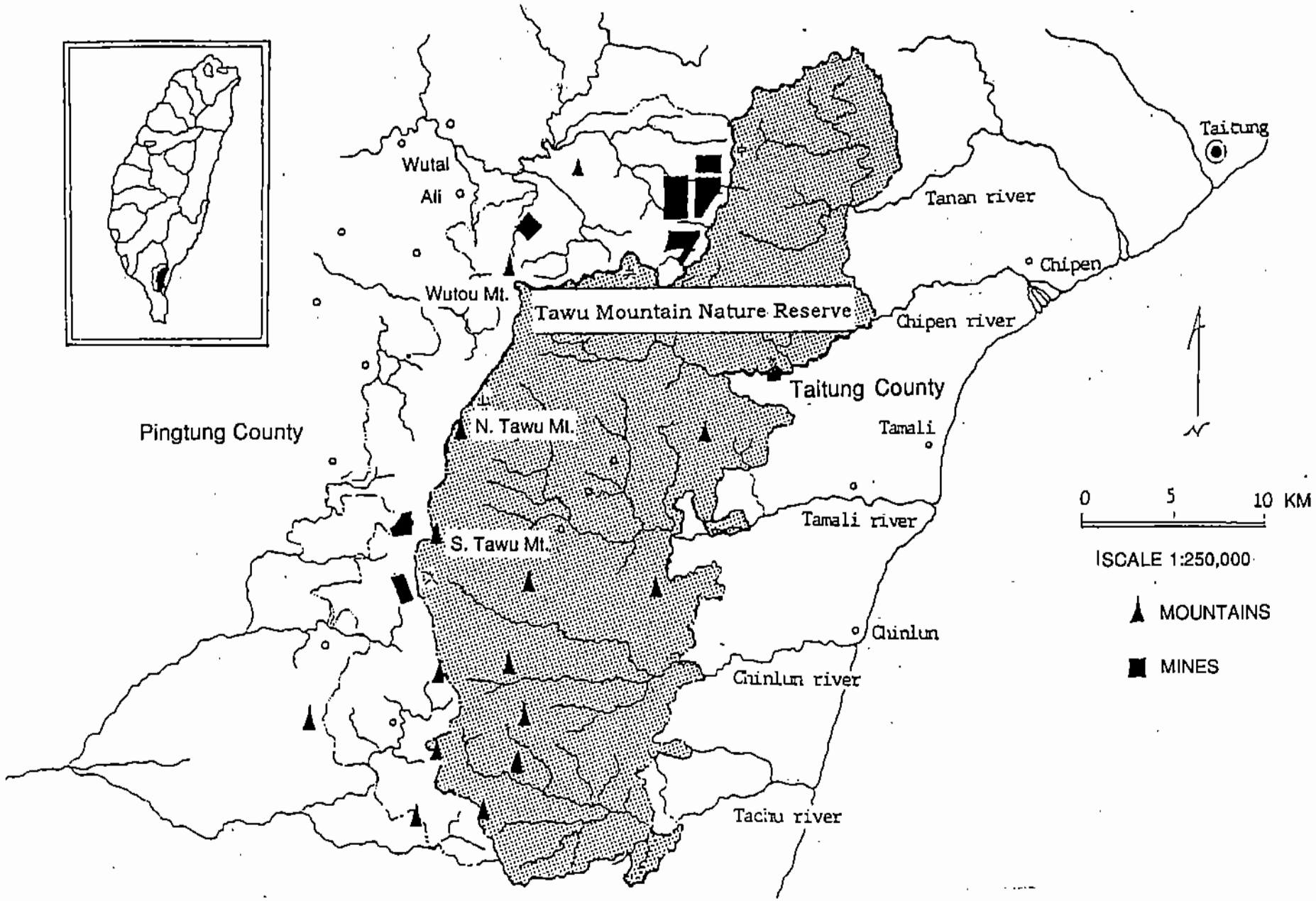


Figure 12. Map of mining operations around Tawu Mountain Nature Reserve.

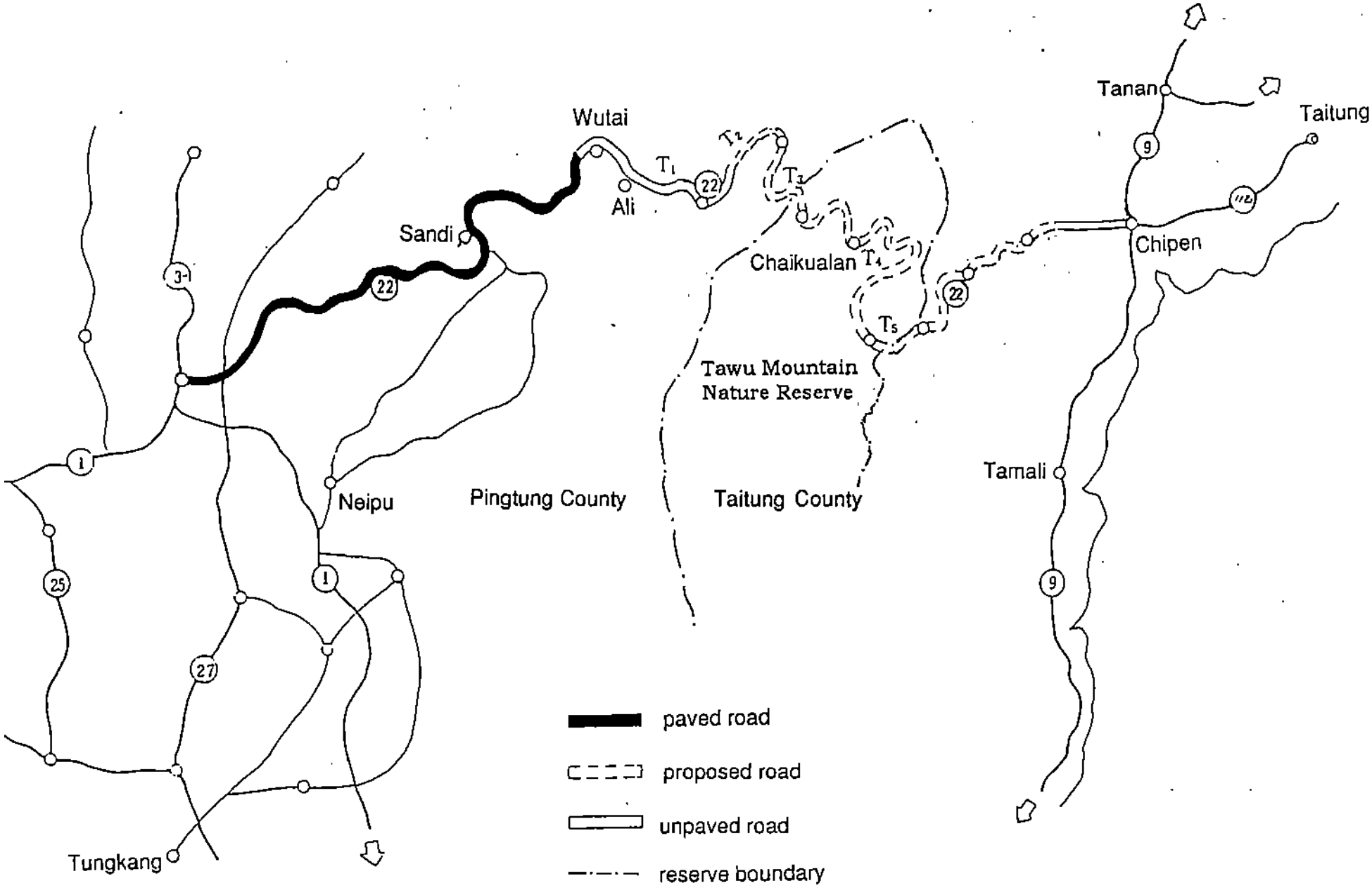


Figure 13. Map of proposed new southern cross island highway.

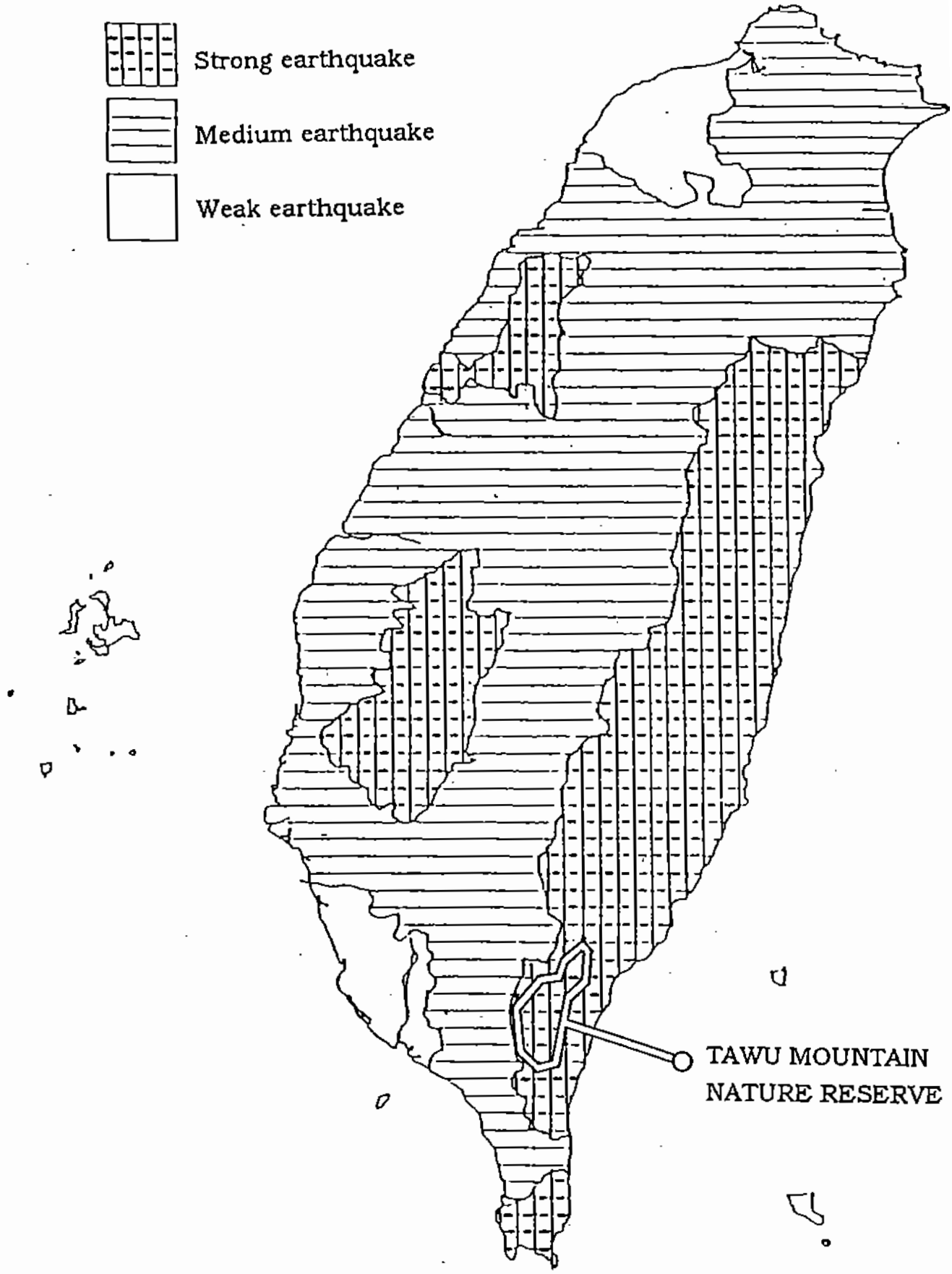


Figure 14. Map of zonation of earthquakes (Taiwan Building Code, 1983).

Table 1. Range and percentage of elevation of Tawu Mountain Nature Reserve.

Elevation	%	Cumulative %
200-300	1.5	1.5
300-400	3.6	5.1
400-500	4.2	9.3
500-600	3	12.3
600-700	8.6	20.9
700-800	7	27.9
800-900	6.5	34.4
900-1000	7.8	42.2
1000-1100	8.2	50.4
1100-1200	6.9	57.3
1200-1300	5.1	62.4
1300-1400	6.3	68.7
1400-1500	6.9	75.6
1500-1600	4.9	80.5
1600-1700	4.4	84.9
1700-1800	4.4	89.3
1800-1900	2.3	91.6
1900-2000	2.5	94.1
2000-2100	1.7	95.8
2100-2200	1.7	97.5
2200-2300	0.6	98.1
2300-2400	0.6	98.7
2400-2500	0.2	98.9
2500-2600	0.4	99.3
2600-2700	0.4	99.7
2700-2800	0	99.7
2800-2900	0	99.7
2900-3000	0	99.7
3000-3100	0.2	100

Table 2. Range and percentage of slope of Tawu Mountain Nature Reserve.

Slope	%	Cumulative%
9°05'	0.8	0.8
13°30'	0.6	1.4
17°45'	2.3	3.7
21°48'	5.3	9
25°38'	13.9	22.9
29°15'	19.4	42.3
32°37'	18.6	60.9
35°45'	15.4	76.3
38°40'	9.5	85.8
41°38'	6.3	92.1
43°50'	3.8	95.9
46°07'	2.1	98
48°14'	1	99
50°12'	0.6	99.6
52°00'	0	99.6
53°40'	0.2	100

Table 3 . Data on stream parameters in 4 watersheds of Tawu Mountain Nature Reserve (CP:Chipen,TM:Tamali,CL:Chinlun,TC:Tachu).

	Stream Parameters												
Station	T	WT	OD	WPH	HS	SL	SH	SPH	CU	FE	NT	AM	RD
CP1	20.00	17.00	8.30	8.60	0.02	0.04	1.20	6.40	0.05	0.25	0.10	0.02	
CP2	22.50	15.50	8.00	8.88	0.02	0.05	2.10	6.50	0.05	0.00	0.10	0.03	
CP3	18.50	15.50	10.20	8.95	0.02	0.04	1.50	6.50	0.05	0.25	0.10	0.03	
CP4	17.00	15.50	0.56	8.92	0.00	0.04	1.50	7.00	0.05	0.25	0.10	0.03	
CP5	17.00	18.50	8.50	7.89	0.00	0.03	1.20	6.80	0.05	0.00	0.10	0.03	
CP6	17.50	17.00	7.50	8.38	0.22	0.04	0.50	7.00	0.05	0.23	0.10	0.03	
CP7	16.00	16.50	8.80	8.03	0.02	0.05	1.10	7.40	0.05	0.00	0.10	0.03	
TM1	26.00	25.50		8.30	0.03	0.05					0.10	0.10	0.40
TM2	25.00	24.00		7.20	0.04	0.04					0.20	0.20	0,30
TM3	21.50	21.00		6.70	0.02	0.03					0.10	0.00	0.20
TM4	20.00	19.00		6.40	0.00	0.04					0.10	0.00	0.30
TM5	21.50	21.00		6.40	0.00	0.04					0.10	0.00	0.30
TM6	21.00	54.00		8.20	0.03	0.05					0.80	0.10	0.40
TM7	21.00	20.00		7.50	0.10	0.04					0.00	0.00	0.30
TM8	20.00	18.00		8.00	0.02	0.07					0.20	0.20	0.50
CL1	15.50	18.00	9.30	9.15	0.02	0.10	0.28	6.50	0.05	0.50	0.10	0.25	0.50
CL2	23.00	49.00	4.30	7.04	0.13	0.01	0.60	6.40	0.10	0.50	0.10	0.10	0.01
CL3	21.00	21.00	9.30	8.12	0.02	0.23	0.70	6.90	0.05	0.25	0.10	0.25	1.70
CL4	20.00	21.00	9.20	7.94	0.02	0.32	0.60	6.40	0.05	0.25	0.10	0.25	2.40
CL5	21.00	18.00	10.20	8.48	0.02	0.32	0.30	6.80	0.05	0.20	0.10	0.03	2.40
TC1	21.50	20.00	15.40	8.10	0.00	0.10					0.00	0.00	0.40
TC2	21.00	19.80	16.50	7.80	0.00	0.01					0.00	0.00	0.70
TC3	23.00	20.50	10.10	7.30	0.00	0.10					0.00	0.00	0.70
TC4	23.00	20.50	10.20	7.60	0.00	0.10					0.00	0.00	0.70
TC5	22.00	20.00	18.70	7.50	0.00	0.10					0.00	0.00	0.70
TC6	20.00	19.00	18.90	7.30	0.00	0.05					0.00	0.00	o,40
TC7	19.00	19.00	10.30	6.80	0.00	0.04					0.00	0.00	0.30
TC8	18.50	18.50	17.50	7.00	0.00	0.04					0.00	0.00	0.30

T: TEMPERATURE
WT: WATER TEMPERATURE
OD: DISSOLVED OXYGEN
WPH: WATER PH
HS: HYDROGEN SULFIDE
SL : SALINITY
SH: SOIL HUMIDITY
SPH: SOIL PH
CU : COPPER ION
FE : IRON ION
NT: NITRITE
AM: AMMONIA
RD: RELATIVE DENSITY

Table 4. Plant list of Tawu Mountain Nature Reserve.

PTERIDOPHYTA

Psilotaceae

Psilotum nudum (L.) Beauv.

Lycopodiaceae

Lycopodium carinatum Desv.
Lycopodium serratum Thunb.

Selaginellaceae

Selaginella delicatula (Desv.) Alston
Selaginella doederleinii Hieron.
Selaginella tamariscina (Beauv.) Spring

Equisetaceae

Equisetum ramosissimum Desf.

Marattiaceae

Angiopteris lygodiifolia Rosen St.

Osmundaceae

Osmunda banksiaefolia (Presl) Kuhn.

Schizaeaceae

Lygodium japonicum (Thunb.) Sw.

Gleichenlaceae

Dicranopteris linearis (Burm.f.) Under

Hymenophyllaceae

Mecodium badium (Hook & Grev.) Copel.
Mecodium polyanthos (Sw.) Copel.
Vandenboschia auriculata (Blume) Copel.

Disksoniaceae

Cibotium cumingii Kunze

Cyatheaceae

Alsophila podophylla Hook.
Sphaeropteris lepifera (Hook.) Tryon

Plagiogyriaceae

Plagiogyria euphlebia (Kunze) Mett.
Plagiogyria glauca (Blume) Merr. var. *philippinensis* Christ
Plagiogyria stenoptera (Hance) Diels

Blechnaceae

Woodwardia orientalis Sw.

Polypodiaceae

Arthromeris lehmanni (Mett.) Ching
Colysis elliptica (Thunb.) Ching
Colysis wrightii (Hook.) Ching
Goniophlebium argutum (Wall.) J. Sm.
Lemmaphyllum microphyllum Presl.
Lepidogrammitis rostrata (Beddome) Ching
Lepisorus thunbergianus (Kaulf.) Ching
Lepisorus obscure-venulosus (Hay.) Ching
Leptochilus decurrens Blume
Loxogramme remote-frondigera Hay.
Microsorium buergerianum (Miq.) Ching
Microsorium punctatum (L.) Copel.
Pseudodrynaria coronans (Mett.) Ching
Pyrrosia polydactylis (Hance) Ching

Grammitidaceae

Ctenopteris curtisii (Bak.) Tagawa

Vittariaceae

Vittaria flexuosa Fee
Vittaria zosterifolia Willd.

Dennstaedtiaceae

Microlepia strigosa (Thunb.) Presl
Monachosorum henryi Christ.

Lindsaeaceae

Lindsaea odorata Roxb.
Sphenomeris chusana (L.) Copel

Davalliaceae

Araiostegia perdurans (Christ) Copel.
Davallia griffithiana Hook.

Pteridaceae

Pteris ensiformis Burm.
Pteris dispar Kunze.
Pteris multifida Poir.
Pteris longipinna Hayata

Pteris semipinnata L.
Pteris tokioi Masam.
Pteris vittata L.

Adiantaceae

Adiantum capillus-veneris L.
Coniogramme intermedia Hieron.

Oleandraceae

Nephrolepis auriculata (L.) Trimen
Nephrolepis hirsutula (Forst.) Presl

Aspidiaceae

Ctenitis apiciflora (Wall.) Ching
Tectaria kwarenkoensis (Hayata) C. Chr.
Tectaria simonsii (Beddome) Ching

Lomariopsidaceae

Elaphoglossum conforme (Sw.) Schott

Dryopteridaceae

Arachniodes aristata (Forst) Tindle
Arachniodes globisora (Hayata) Ching
Arachniodes rhomboides (Wall.) Ching
Cyrtomium falcatum (L. f.) Presl
Dryopteris sparsa (Don) Ktze
Dryopteris subexaltata (Christ) C. Chr.
Leptorumohra quadripinnata (Hayata) H. Ito.

Thelypteridaceae

Christella parasitica (L.) Lev.
Cyclogramma auriculata (J. Sm.) Ching
Macrothelypteris torresiana (Gaud.) Ching
Metathelypteris gracilescens (Blume) Ching
Parathelypteris beddomei (Bak.) Ching
Pneumatopteris truncata (Poir.) Holtt.

Athyriaceae

Anisogonium esculentum (Retz) Presl.
Athyrium nakanoi Makino
Cornopteris fluvialis (Hayata) Tagawa
Diplazium dilatatum Bl.

Aspleniaceae

Asplenium adiantum-nigrum L.
Asplenium antiquum Makino
Asplenium excisum Presl
Asplenium nidus L.
Asplenium normale Don
Asplenium planicaule Wall. ex Hook.
Asplenium unilaterale Lam.

GYMNOSPERMAE

Taxaceae

Taxus mairei (Lemee & Levl.)Huex Liu

Cephalotaxaceae

Cephalotaxus wilsoniana Hayata

Pinaceae

Tsuga chinensis (Franch.) Pritz. ex Diels var. *formosana* (Hay.) Li & Keng.

Cupressaceae

Chamaecyparis formosensis Matsum.
Juniperus formosana Hay.

Dicotyledoneae

Myricaceae

Myrica rubra Sieb et Zucc.
Myrica rubra Sieb. & Zucc. var. *acuminata* Nakai

Juglandaceae

Engelhardtia roxburghiana Wall.
Juglans cathayensis D.

Betulaceae

Alnus formosana (Burk.) Makino
Carpinus kawakamii Hayata

Fagaceae

Castanopsis borneensis King
Castanopsis carlesii (Hemsl.) Hay.
Castanopsis subsacuminata Hay.
Cyclobalanopsis glauca (Thunb.) Oerst.
Cyclobalanopsis longinux (Hayata) Schott
Cyclobalanopsis morii (Hay.) Schott.
Cyclobalanopsis stenophylla (Makino) Liao var. *stenophylloides* (Hay.)
Lithocarpus amygdalifolius (Skan) Hayata
Lithocarpus lepidocarpus (Hay.) Hay.
Pasania chiaratuangensis (Liao) Liao
Pasania kawakamii (Hayata) Schott
Pasania randaiensis (Hayata) Hayata
Pasania ternaticupula (Hayata) Schott
Quercus variabilis Blume

Ulmaceae

Celtis formosana Hayata
Celtis sinensis Pers.
Zelkova serrata (Thunb.) Makino

Moraceae

Artocarpus lanceolata Trec
Broussonetia papyrifera (L.) L'Herit ex Vent.
Cudrania cochinchinensis (Lour.) Kudo & Masamune var. *gerontogea* (Sieb. & Zucc.) Kudo & Masamune
Ficus benjamina L.
Ficus erecta Thunb var. *beecheyana* (Hook & Arn.) King.
Ficus formosana Maxim
Ficus irisana Elemn.
Ficus microcarpa Linn. f.
Ficus nervosa Heyne
Ficus septica Burm f.
Ficus thwaitesii Miq.
Ficus vaccinioides Hemsl & King
Ficus variegata Blume var. *obtusa* (Hassk.) Comer.
Ficus wightiana Wall & Benth
Malaisia scandens (Lour.) Planch.
Morus alba L.
Morus australis Poir.

Urticaceae

Boehmeria densiflora Hook. & Arn.
Boehmeria formosana Hayata
Debregeasia edulis (Sieb & Zucc.) Webb
Elatostema edule Rob.
Elatostema lineolatum Forst. var. *major* Thwait
Laportea pterostigma Wedd.
Pellionia radicans (Sieb. & Zucc.) Wedd.
Pilea microphylla (Linn.) Liebn
Villebrunea pedunculata Shirai

Proteaceae

Grevillea robusta A. Cunn.
Helicia formosana Hemsl.

Loranthaceae

Aspidixia liquidambaricolus (Hayata) Danser.

Polygonaceae

Achyranthes japonica (Miq.) Nakai
Polygonum chinense L.
Polygonum multiflorum Thunb. var. *hypoleucum* (Ohwi) Liu.Ying Lai
Polygonum perfoliatum L.
Polygonum thunbergii Sieb et Zucc.

Basellaceae

Basella alba L.

Caryophyllaceae

Drymaria cordata (L.) Willl. subsp. *diandra* (Blume) I. Duke ex Hatasima

Amaranthaceae

Celosia taitoensis Hay.

Magnoliaceae

Michelia compressa (Maxim.) Sargent

Schisandraceae

Schisandra arisanensis Hayata

Illiciaceae

Illicium arborescens Hayata
Illcium philippinense Merr.

Lauraceae

Beilschmiedia erythrophloia Hqayata
Cinnamomum brevipedunculatum Chang
Cinnamomum camphora (Linn.) Nees & Eberm.
Cinnamomum insularimontanum Hayata
Cinnamomum osmophloeum Kanehira
Cryptocarya concinna Hance
Litsea acutivena Hayata
Litsea akoensis Hayata
Litsea cubeba (Lour.) Persoon
Litsea hypophyea Hayata
Litsea nakaii Hay.
Litsea lii Chang
Litstea serisea (Blume) Koidz. var. *aurata* (Hayata) Hatusina
Litsea taiwaniana Kamitoti
Neolitsea acuminatissima (Hayata) Kanehira & Sasaki
Neokitsea konishii (Hay) kanehira & Sasaki
Persea thunbergii (Sieb. & Zucc.) Kostermans
Persea zuihoensis (Hayata) Li
Phoebe formosana (Hayata) Hayata

Trochodendraceae

Trochodendron aralioides Sieb. & Zucc.

Ranunculaceae

Clematis gouriana Roxb
Clematis uncinata Benth. var. *taitongensis* Liu & Ou

Berberidaceae

Berberis kawakamii Hayata
Mahonia japonica (Thunb.) DC.

Lardizabalaceae

Stauntonia hexaphylla (Thunb.) Dence.

Menispermaceae

Cocculus trilobus (Thunb.) DC.
Pericampylus formosanus Diels.
Stephania japonica (Thunb.) Miers

Piperaceae

Peperomia nakaharai Hayata
Piper kadsura (Choisy) Ohwi

Chloranthaceae

Chloranthus spicatus (Thunb) Makine

Aristolochiaceae

Aristolochia shimadai Hyata

Actinidiaceae

Actinidie callosa Lindl. var. *formosana* Finet & Gagnep.
Saurauia oldhamii Hemsl.

Capparidaceae

Crateva adansonii DC. subsp. *formosensis* Jacobs.

Theaceae

Adinandra lasiostyla Haya
Eurya acuminata DC.
Eurya glaberrima Hayata
Eurya japonica Thunb.
Eurya strigillosa Hayata
Gordonia axillaris (Roxb.) Dietr.
Gordonia axillaris (Roxb.) Dietr. var. *tagawae* (Ohwi) Keng.
Pyrenaria shinkoensis (Hayata) Keng.
Schima superba Gardn. & Champ.
Schima superba Gardm. & Champ. car. Kankoensis (Hay.) Keng.

Hamamelidaceae

Liquidambar formosana Hance

Guttiferaceae

Garcinia multiflora Champ.

Capparidaceae

Capparis sikkimensis Kuiz. subsp. *formosana* (Hemsl.) Jacobs.

Saxifragaceae

Deutzia pulchra Vidal
Hygrangea angustipetala Hayata
Hydrangea chinensis Maxim.
Hydrangea anomala Don
Hydrangea integrifolia Hayata ex Matsum.
Hydrangea longifolia Hayata
Itea oldhamii Schneider

Pittosporaceae

Pittosporum tobira Ait

Rosaceae

Duchesnea indica (Andr.) Focke
Eriobotrya deflexa (Hemsl.) Nak.
Pruns phaeosticta (Hance) Maxim
Rosa taiwaninsis Nakai
Rubus aculeatiflorus Hay. var. *taitoensis* Liu & Yang
Rubus calycinoides Hayata
Rubus formosensis Ktze.
Rubus glandulos-calycinus Hay.
Rubus mesogaeus Focke.
Rubus parvifolius Linn.
Rubus pectinellus Maxim. var. *trilobus* Koidz.
Rubus pinfanensis Lev. & Van.
Rubus swinchoei Hance
Spiraea formosana Hayata

Leguminacae

Acacia confusa Merr.
Acacia intsia (L.) Willd.
Albizzia falcatar Bacher ex Meril.
Alysicarpus vaginalis (L.) DC.
Bauhinia blakeana Dunn.
Cassia siamea Lam.
Centrosema pubescens Benth.
Christia campanulata (Benth) Thoth.
Leucaena glauca (L.) Benth
Millettia reticulata Benth.
Pithecellobium dulce (Roxb.) Benth
Pithecellobium lucidum Benth.
Pueraria lobata (Willd) Ohwi

Oxalidaceae

Oxalis acetosella L. subsp. *japonica* (Fr. & Sav.) Hara

Geraniaceae

Geranium nepalense Sweet var. *thunbergii* (sieb. & Zucc.) Kudo

Euphorbiaceae

Acalypha akoensis Hayata
Acalypha formosana Hayata
Aleuriters cordata (Thunb.) R. Br. ex Steud
Antidesma pentandrum Merr. var. *barbatum* (Presl.) Merr.
Bischofia javanica Bl.
Breynia officinalis Hemsl.
Bridelia balansae Tutch.
Bridelia tomentosa Blume
Drypetes karapinensis (Hayata) Pax.
Drypetes littoralis (C. B. Rob.) Merr.
Glochidion rubrum Blume
Glochidion zeylanicum (Gaertn.) A. Juss.
Macaranga tanarius (L.) Muell-Arg.
Mallotus japonicus Muell.-Arg.
Mallotus paniculatus (Lam.) Muell.-Arg.
Manihot esculenta Crantz.
Melanolepis multiglandulosa (Reinw.) Reich. f. & Zoll.
Ricinus communis L.

Daphniphyllaceae

Daphniphyllum glaucescens Blume subsp. *oldhamii* (Hemsl.) Huang

Rutaceae

Clausena lunulata Hay.
Evodia merrilli Kanch.
Glycosmis citrifolia (Willd) Lindl.
Murraya paniculata L.
Skimmia arisanensis Hayata
Zanthoxylum nitidum (Roxb.) DC.

Meliaceae

Aglaia odorata Lour.
Dysoxylum kusukusense (Hayata) Kanehira & Hatusima
Melia azedarach L.
Swietenia mahogoni (L.) Jaca.

Malpighiaceae

Hiptage benghalensis (L.) Kurz

Coriariaceae

Coriaria intermedia Matsum.

Anacardiaceae

Rhus semialata Murr. var. *roxburghiana* DC.
Rhus succedanea L.
Semecarpus gigantifolia Vidal.

Aceraceae

Acer kawakamii Koidz
Acer palmatum Thunb.
Acer morrisonense Hayata,
Acer serrulatum Hay.

Sapindaceae

Sapindus mukorossii Gaertn.

Aquifoliaceae

Tlex asprella Champ.
Ilex bioritsensis Hayata
Ilex yunnanensis Fr. var. *parvifolia* (Hay.) S. Y. Hu.

Celastraceae

Celastrus hindsii Benth.
Euonymus acuto-rhombifolia Hayata
Euonumus echinatus Wall.
Euonymus motsudai Hayata

Staphyleaceae

Euscaphis japonica (Thunb.) Kanitz
Turpinia formosana Nakai
Turpinia ternata Nakai

Buxaceae

Buxus harlandii Hance

Rhamnaceae

Rhamnus formosana Matsum

Vitaceae

Ampelopsis brevipedunculata (Maxim) Trautv.
Cayratia japonica (Thunb.) Gagnep
Tetrastigma formosanum (Hemsl.) Gagnep

Elaeocarpaceae

Elaeocarpus japonicus Sieb. & Zucc.
Elaeocarpus sylvestris (Lour.) Poiret
Sloanea formosana Li
Triumfetta bartramia Linn

Malvaceae

Abutilon indicum (L.) Sweet.
Hibiscus sabdariffa Linn.
Hibiscus mutabilis L.
Sida insularis Hatushima

Sida rhombifolia L.
Urena lobato L.

Thymelacaceae

Daphne arisanensis Hayata

Sterculiaceae

Pterospermum acerifolium Will.

Elaeagnaceae

Elaeagnus formosana Nakai

Flacourtiaceae

Idesia polycarpa Maxim.
Scolopia oldhamii Hance

Passifloraceae

Passiflora edulis Sims
Passiflora laurifolia Linn.

Stachyuraceae

Stachyurus himalaicus Hook. f. & Thomson ex Benth.

Begoniaceae

Begonia aptera Bl.
Begonia laciniata Roxb.

Cucurbitaceae

Diplocyclos palmatus (L.) C. Jeffrey
Ibervillea sonorae (Wats.) Greene ex Small
Melothria formosana Hayata
Momordica cochinchinesis (Lour.) Spreng
Trichosanthes multiloba Miq

Lythraceae

Lagerstroemia subcostata Koehne

Myrtaceae

Psidium guajava L.

Melastomataceae

Barthea formosana Hayata
Melastoma candidium D. Don
Pachycentria formosana Hayata

Cornaceae

Helwingia japonica (Thunb.) Dietr. subsp. *formosana* (Kanehira & Sasaki) Hara & Kurosawa.

Araliaceae

Acanthopanax trifoliatus (L.) Merr.
Dendropanax pellucidopunctata (Hayata) Kaneh. ex Kaneh. & Hatusima
Fatsia polycarpa Hayata
Hedera rhombea (Miq.) Bean var. *formosana* (Nakai) Li
Schefflera arboricola Hayata
Schefflera octophylla (Lour) Harmsin
Sinopanax formosana (Hayata) Li
Tetrapanax papyriferus (Hook.) K. Kock

Umbelliferae

Centella asiatica (L.) Urban
Hydrocotyle nepalensis Hook.

Ericaceae

Gaultheria itoana Hayata
Gaultheria leucocarpa Blume forma *cumingiana* (Vidal) Sleumer
Lyoniaa ovalifolia (Wall.) Drude
Pieris taiwanensis Hayata
Rhododendron ellipticum Maxim.
Rhododendron tashiroi Maxim.
Rhododendron morii Hayata
Rhododendron rubropilosum Hay.
Rhododendron taiwanianum Ying
Vaccinium dunalianum Wight var. *caudatifolium* (Hay.) Li
Vaccinium merrillianum Hayata
Vaccinium randaiense Hayata

Myrsinaceae

Ardisia brevieaulis Diels
Ardisia cornudentata Mez
Ardisia cripa (Thunb) DC. var. *dielsii* (Leu) Walk.
Ardisia crenata Sims
Ardisia sieboldii Miq.
Ardisia virens Kurz
Maesa japonica Moritziin
Maesa tenera Mez.

Plumbaginaceae

Plumbago zeylanica L.

Sapotaceae

Palaauium formosanum Hayata.

Ebenaceae

Diospyros discolor Willd.
Diospyros eriantha Champ. ex Benth.
Diospyros japonica Sieb. & Zucc.
Diospyros morrisiana Hance

Styracaceae

Styrax formosana Matsum.
Styrax suberifolia Hook & Arn

Symplocaceae

Symplocos anomala Brand.
Symplocos cochinchinensis (Lour.) Moore subsp. *laurina* (Retz.) Nooi.
Symplocos glauca (Thunb.) Koidz.
Symplocos lancifolia Sieb. & Zucc.
Symplocos modesta Brand
Symplocos koshunensis Kaneh.
Symplocos paniculate (Thunb) Mig.
Symplocos stellaris Brand

Oleaceae

Fraxinus formosana Hayata
Fraxinus insularis Hemsl.
Jasminum hemsleyi Yamamoto
Ligustrum japonicum Thunb. var. *pubescens* Koidz
Osmanthus heterophyllus (Don) Green var. *bibracteatus* (Hayata) Green
Osmanthus Koai (Liu et Liao) Lu

Loganiaceae

Buddleja asiatica Lour.

Apocynaceae

Ecdysanthera rosea Hook. & Arn.

Asclepiadaceae

Dischidia formosana Maxim.
Gymnema atternifolium (Lour.) Merr.
Hoya carnosa (L. f.) R. Br.
Marsdenia formosana Masamune

Rubiaceae

Damnacathus indicus Gaertn.
Galium spurium L. var. *echinospermum* (Wall.) Hayek.
Gardenia jasminoides Ellis
Geophila herbacea (Jacq.) Ktze.
Lasianthus chrtisii King & Gamble
Lasianthus cyanocarpus Jack.
Lasianthus microphyllus Elmer.

Lasianthus obliquinerivis Merr.
Lasianthus plagiophyllus Hance
Mussaenda parviflora Matsum
Mussaenda pubescens Ait. f.
Mussaenda taiwaniana Kanehira
Ophiorrhiza inflgta Maxim.
Ophiorrhiza japonica Blume
Paederia seandens (Lour.) Merr.
Psychotria serpens L.
Psychotria rubra (Lour.) Poir.
Randia cochinchinensis (Lour.) Merr.
Randia spinosa (Thunb.) Poir.
Tarenna gracilipes (Hayata) Ohwi
Tricalysia dubia (Lindl.) Ohwi
Wendlandia uvariifolia Hance

Convolvulaceae

Ipomoea acuminata (Vahl) Roem & Schult.
Ipomoea batatas (L.) Lam.
Ipomoea cairica (L.) Sweet
Ipomoea obscura (L.) Ker-Gawl.
Ipomoea pes-caprae Sweet

Boraginaceae

Trchodesma khasianum Clarke

Verbenaceae

Callicarpa formosana Rolfe
Callicarpa randaiensis Hay.
Clerodendron cyrtophyllum Turcz.
Clerodendrum trichotomum Thumb. var. *fargesii* (Dode) Rehder
Vitex negundo L.

Labiatae

Anisomeles indica (L.) O. Ktze.
Clinopodium gracile (Benth.) Ktze
Hyptis rhomboides Mart. & Gal.
Scutellaria rivularis Benth

Solanaceae

Solanum aculeatissimum Jacq.

Scrophulariaceae

Lindernia procumbens (Krock.) Philcox
Mazus pumilus (Burm. f.) Steenis
Torenia concolor Lindl. var. *formosana* Yamazaki
Veronica beccabunga L.

Bignoniaceae

Radermachia sinica (Hance) Hemsl.

Acanthaceae

Goldfussia formosanus (Moore) Hsieh & Huang

Caprifoliaceae

Lonicera acuminata Wall.
Sambucus formosana Nakai
Viburnum foetidum Wall. var. *rectangulatum* (Graebner) Rehder
Viburnum furcatum Blume ex Maxim.
Viburnum luzonicum Rolfe
Viburnum luzonicum Rolfe var. *formosanum* (Hance) Rehder
Viburnum odoratissimum Ker.
Viburnum Propinquum Hemsl.
Viburnum taitoense Hayata
Viburnum taiwanianum Hayata

Valerianaceae

Patrinia formosana Kitamura

Campanulaceae

Sphenoclea zeylanica Gaertn.

Compositae

Ageratum conyzoides L.
Ageratum Houstonianum Mill.
Artemisia capillaris Thunb.
Aster subulatus Michaux
Bidens bipinnata L.
Crassocephalum rabens (Juss. ex Jacq.) S. Moore.
Elephantopus mollis H.B.K.
Erigeron canadensis L.
Euparorium tashiroi Hayata
Ixeris chinensis Nakai
Ixeris laevigata (Blume) Schultz-Bip. ex Maxim. var. *oldhami* (Maxim.) Kitamura.
Vernonia cinerea (L.) Less.

MONOCOTYLEDONEAE

Liliaceae

Aspidistra daibuensis Hayata
Dianella ensifolia (L.) DC. ex. Redoute
Disporum kawakami Hayata
Ophiopogon formosanum Ohwi
Peliosanthes tashiroi Hayata
Smilacina formosana Hayata
Tricyrtis formosana Bak.

Dioscoreaceae

Dioscorea bulbifera L.
Dioscorea japonica Thunb. var. *oldhamii* Uline ex Knuth

Hypoxidaceae

Curculigo capitulata (Lour.) Ktze.

Smilacaceae

Heterosmilax indica A. DC.
Smilax bractata Presl.
Smilax lanceaefolia Roxb. var. *opaca* A.

Commelinaceae

Amischotolype chinensis (N. E. Br.) E. H. Walker ex Hatusima
Commelina communis L.
Murdannia keisak (Hassk) Hand-Mazz
Pollia japonica Thunb.

Cyperaceae

Baeothryon subcapitatum (Thwaites) T. Koyama
Carex baccans Nees
Cyperus distans L. f.
Mariscus sieberiamus (Mees) K. Schum.
Scirpus ternatanus Reinw ex Miq.

Gramineae

Arundo formosana Hack
Axonopus affinis Chase
Bambusa arundinacea (Retz.) Willd.
Bambusa stenostachya Hac Kel
Bambusa stenostachya Hackelin Bull
Coix lacryma-jobi L.
Echinochlia colonum (L.) Link
Imperata cylindrica (L.) P. Beauv. var. *major* (Nees) C. E. Hubbard
Isachne globosa (Thunb.) Ktze.
Lopatherum gracile Brongn.
Miscanthus floridulus (Labill.) Warb. ex Schum & Laut.
Miscanthus transmorrisonensis Hayata
Miscanthus kanehirai Honda.
Panicum repens L.
Paspalum conjugatum Berg.
Paspalum distichum L.
Phragmites communis (L.) Trin.
Phragmites karka (Retz.) Trin. ex Steud.
Phyllostachys pubescens Mazel. ex H. de Leh.
Pseudosasa japonica (Sieb & Zucc.) Makino
Setaria palmifolia (Koen.) Stapf
Sporobolus fertilis (Steud.) W. D. Clayton
Yushania niitakayamensis (Hayata) Keng. f.

Palmae

Areca catechu L.
Arenga engleri Beccari
Daemonorops margaritae (Hance) Beccari

Araceae

Alocasia cucullata Schott. ex. Endl.
Alocasia macrorrhiza (L.) Schott & Endl.
Arisaema heterophyllum Blume.
Monstera deliciosa Liebm
Pothos chinensis (Raf.) Merr.

Pandanaceae

Freycinetia formosana Hemsl.

Musaceae

Musa formosana (Warb.) Hayata
Musa sapientum L.

Zingiberaceae

Alpinia formosana K. Schum

Orchidaceae

Acanthephippium striatum Lindl.
Anoectochilus formosanus Hayata
Calanthe formosana Rolfe
Dandrobium moniliforme (L.) Sw.
Epipogium roseum (D. Don) Lindl.
Galeola altissima (Bl.) Reichb. f.
Pleione formosana Hayata.
Trichoglottis luchuensis (Rolfe) Garay & Sweet.
Malaxis latifolia J. E. Sm.
Mischobulbum cordifolium (Hook. f.) Schltr.

Table 5. Dominant plant associations at different elevations in Tawu Mountain Nature Reserve.

Above 3000m	*Miscanthus transmorrisonensis* Hay. *Yushania niitakayomonsis* (Hsy.) Keng T. *Baeothryon subcapitatum* (Thwaites) T. Koyama
1900-3090m	*Tsuga chinensis* (Franch.) Pritz. ex Diels var. *formosana* (Hay.) Li & Keng (80.6%)
	Eurya glaberima Hay. (5.3%) *Illicium philippinense* Merr. (4.5%) *Symplocos lancifolia* Sieb. & Zucc. (0.3%) *Neolitsea acuminatissima* (Hay.) Kaneh. & Sasaki (0.2%) *Osmanthus heterophyllus* (Don) Green var. *bibracteatus* (Hay.) Green (0.2%)
	Plagiogyria glauca (Blume) Merr. var. *philiippinensis* Christ (9.2%)
1700-2500m	*Chamaecyparis formosensis* Matsum.
	Castanopsis carlesii (Hemsl.) Hay. *Cyclobalanopsis morii* (Hay) Schott. *Lithocarpus lepidocarpus* (Hay>) Hay. *Persea thurbergii* (Sieb. & Zucc.) Kosterm. *Trochodendron aralioides* Sieb. & Zucc. *Michelia compressa* (Maxim.) Sargent *Heolitsea acuminatissima* (Hay.) Kanch. & Snsali
	Illocoum philippinense Merr. *Rhododendron ellipticum* Maxim. *Adinandra lasiostyla* Hay.
1000-1500m	*Machilus japonica* Sieb (60%) *Litsea ecuminata* (L. Blume Kurata *Fatsia polycarpa* Hay. *Illicium ardborescens* Hay. *Symplllocos anomala* Brond *Castanopsis carlesii* (Hemsl.) Hay.
	Elatostema edule Rob. *Elatostema lineolatumforst* var. *major* Thwait
320-1000m	*Lagerstroemia subcostata* Koehne *Calamus margaritae* Hanu. *Arenga engleri* Beccari *Macaranga tanarius* (L.) Muell-Arg. *Litsea taiwaniana* Kamitoti *Alpinia formosana* Schum *Eriobotrya deflexa* (Hemsl.) Nak. *Persea zuihoensis* (Hay.) Li *Ardisia squamulosa* Presl. *Evodia merrilli* Kaneh. *Rsychotria rubra* (Lour.) Poir. *Callicarpa formosana* Rolfe *Lirsea acuminata* (Blume) Kurata *Heljcia formosana* Hemsl.

Table 5. (cont.)

320-1000m (cont.)	*Persea japonica* Sieb. ex Sieb. & Zucc.
	Fraxinus formosana Hay.
	Cyclobalanopsia glauca (Thunb.) Oerst.
	Litsea acuminata (Blume) Lurate
	Elaeocarpus sylvestris (Lour.) Poiret
	Sapindus mukorossi Gaertn.
	Diospyros erinntha Champ. ex Benth.
	Bauhinia championii Benth.
	Milletia reticulata Benth.
	Smilax sebeana Miq.
Below 500m	
400-500m	*Fraxinus formosana* Hay.
	Psydhotria rubra (Lour.) Poir.
	Miscanthus floridulus (Labill.) Warb. ex Schum. & Lout.
	Arundo formosana Hack.
	Acalypha akoensis Hayata
	Mallotus paniculatus (Lam.) Muell.-Arg.
	Ficus wrightiana Wall
	Laportea pterostigma Wedd.
	Arenga engleri Beccari
	Daemonorops margaritae (Hance) Beccari
	Lirsea acuminata (Blume) Kurata
	Schefflera octophylla (Lour.) Harms
	Morus australis Poir.
	Evodia merrilli Kaneh.
	Celtis sinensis Pers.
	Lasianthus plagiophyllus Hance
	Ardisia comudentata Mez
	Isachne globosa (Thunb.) Ktze.
	Elephantopus mollis H. B. K.
	Acanthopanax trifoliatus (L.) Merr. *formosana* (Hay.) Kltamura
	Stauntonia hexaphylla (Thunb.) Decne.
	Piper kadsura (Choisy) Ohwi
	Smilax cnina Linn.
	Pseudodrynaria coronans (Wall.) Ching
	Selaginella delicatula (Desv.) Alston
250-400m	*Cyclobalanopsia glauca* (Thunb.) Oerst.
	Eriobotrya deflexa (Hemsl.) Nak.
	Lagerstrocmia subcostata Koehne
	Rhus semialata Murr. var. *roxburghiana* DC.
	Artemisia capillaris Thunb.
	Aspidistra daibuensis Hay.
	Ophiopogon formosanum Ohwi
	Lepisorus thunbergianus (Kaulf.) Ching
	Nephrolepis biserrata (Sw.) Schott
Below 250m	*Miscanthus floridulus* (Labill.) Warb. ex Schum. & Lout.
	Arundo formosana Hack.
	Macaranga tanarius (L.) Muell-Arg.
	Hibiscus mutabilis L.
	Deutzia pulchra Vidal.
	Bochmeria densiflora Hook. & Arn.

Table 6. Plant species at the river valley along Tachu and Tamali waterways (sampling plot #4515).

Scientific name	Family name	Dispersion*	Coverage@ (%)	Height (cm)
Asplenlun antiquum Makino	*Aspleniaceae*	+	+	30
Equisetum ramosissimum Desf.	*Equisetaceae*	+	+	50
Miscanthus floridulus (Labill.) Warb. ex Schum & Laut.	*Gramineae*	4	60	220
Arundo formosana Hack.	*Gramineae*	4	30	170
Pueraria lobata (Willd) Ohwi	*Leguminasae*	+	+	250
Pueraria lobata (Willd) Ohwi	*Leguminasae*	+	+	150
Albizzia falcatar Bacher ex Meril.	*Leguminasae*	+	+	150
Hibiscus mutabilis L.	*Malvaceae*	+	+	400
Ficus septica Burm f.	*Moraceae*	+	+	1000
Morus sustralis Poir.	*Moraceae*	+	60	450
Fraxinus formosana Hayata	*Oleaceae*	+	+	200
Nephrolepis biserrata (Sw.) Schott	*Oleandraceae*	4	30	150
Pteris ensiformis Burm.	*Pteridaceae*	3	2	130
Smilax lanceaefolia Roxb. var. opaca A.	*Smilacaceae*	+	1	200
Laportea pterostigma Wedd.	*Urticaceae*	+	+	120
Alpinia formosana Schum	*Zingiberaceae*	+	2	230

* Dispersion: +single, 1 scarce---5 dense
@ Coverage: +<1%

Table 7. Plant species of warm temperate broad-leaved forest in Tawu Mountain Nature Reserve (sampling plot #4412).

Scientific name	Family name	Dispersion*	Coverage@ (%)	Height (cm)
Alocasis macrorrhiza (L.) Schott & Endl.	*Araceae*	+	+	70
Acanthopanax trifoliatus (L.) Merr. formosana (Hay.) Kitamura	*Araliaceae*	+,1	3	50-120
Schefflera otophylla (Lour) Harmsin Engler	*Araliaceae*	+	+	400-600
Acalypha akoensis Hayata	*Ephorbiaceae*	+	10	800
Breynia officinalis Hemsl.	*Euphorbiaceae*	+	+	1000
Macaranga tanarius (L.) Muell-Arg.	*Euphorbiaceae*	+	2	800
Mallotus japonicus Muell-Arg.	*Euphorbiaceae*	+	+	1000
Mallotus paniculatus (Lam.) Muell-Arg.	*Euphorbiaceae*	+	5	1000
Cyclobalanopsis glacua (Thunb.) Oerst.	*Fagaceae*	+	15	1000
Miscanthus floridulus (Labill) Warb. ex Schum & Laut.	*Gramineae*	+,1	5	100
Persea zuihoensis (Hayata) L.	*Lauraceae*	+	5	1000
Litsea acuminata (Blume) Lurate	*Lauraceae*	+	10	900
Acacia confuss Merr.	*Leguminasae*	+	5	1000
Pueraria lobata (Willd) Ohwi	*Leguminasae*	+	+	800
Fraxinus formosana Hayata	*Oleaceae*	+,4	35	3-10 m
Arenga engleri Beccari	*Palmae*	+	1	500
Eriobotrya deflexa (Hemsl) Nak.	*Rosaceae*	+	+	1000
Celtis sinesis Pers.	*Ulmaceae*	+	+	800
Evodia merrilli Kaneh.	*Rutaceae*	+	+	1000
Trema orientalis Blume.	*Ulmaceae*	+	+	1000
Laportea pterostigma Wedd.	*Urticaceae*	+	5	1000
Alpinia formosana Schum	*Zingiberaceae*	+	+	200

* Dispersion: +single, 1 scarce---5 dense
@ Coverage: +<1%

Table 8. Mammal species found in Tawu Mountain Nature Reserve based on surveys from March, 1987 to December, 1988.

Order	Family	Species	Common Name	Endemic	Status
Insectivora	Talpidae	*Talpa micrura*	Formosan Mole	•	
	Soricidae	*Episoriculus fumidus*	Formosan Shrew	••	
Primate	Cercopithecidae	*Macaca cyclopis*	Formosan Macaque	••	T
Lagomorpha	Leporidae	*Lepus sinensis formosus*	Formosan Hare	•	
Pholidota	Manidae	*Manis pentadactyla pentadactyla*	Chinese Pangolin	•	T
Rodentia	Sciuridae	*Callosciurus erythraeus*	Red-bellied Tree Squirrel		
		Tamiops swinhoei formosanus	Formosan Striped Squirrel	•	
		Belomys pearsoni	Formosan Hairy-footed Flying Squirrel	•	
		Petaurista petaurista grandis	Formosan Giant Flying Squirrel	•	
		Petaurista alborufus lena	White-faced Flying Squirrel	•	
	Muridae	*Rattus coxinga*	Spiny Country Rat		
		Rattus culturatus	Formosan White-bellied Rat	••	
		Apodemus semotus	Wood Mouse	••	
Carnivora	Ursidae	*Selenarctos thibetanus formosanus*	Formosan Black Bear	•	E
	Mustelidae	*Melogale moschata subaurantiaca*	Formosan Ferret-badger	•	
		Martes flavigula chrysospila	Formosan Yellow-throated Marten	•	R
		Mustela sibirica davidiana	Chinese Weasel	•	
		? *Lutra lutra*	Chinese Otter		E
	Viverridae	*Paguma larvata taivana*	Formosan Gem-faced Civet	•	T
		Herpestes urva	Crab-eating Mongoose		
		Viverricula indica pallidea	Small Chinese Civet	•	R
	Felidae	*Felis bengalensis chinensis*	Leopard Cat	•	R
		? *Neofelis nebulosa brachyurus*	Formosan Clouded Leopard	•	E
Artiodactyla	Suidae	*Sus scrofa taivanus*	Wild Boar	•	
	Cervidae	*Muntiacus reevesi micrurus*	Formosan Muntjac	•	T
		Cervus unicolor swinhoei	Formosan Sambar	•	T
	Bovidae	*Capricornis crispus swinhoei*	Formosan Serow	•	T

•• Endemic species
• Endemic subspecies
R Rare
T Threatened
E Endangered (listed to be protected under the Culture Heritage Preservation Act)
? Based on interview

Table 9. Bird species found in Tawu Mountain Nature Reserve based on surveys from March, 1987 to December, 1988.

Order	Family	Species	Common Name	Endemic	Status
Ciconiiforms	Ardeidae	*Butorides striatus*	Little Green Heron		C
Anseriformes	Anatidae	*Anas acuta*	Pintail		C
		Aix galericulata	Mandarin Duck		R
Falconiformes	Accipitridae	*Accipiter trivirgatus*	Crested Goshawk	•	C
		Spizaetus nipalensis	Hodgson's Hawk Eagle		E
		Spilornis cheela	Serpent Eagle	•	C
	Falconidae	*Falco tinnunculus*	Commom Kestrel		C
Galliformes	Phasianidae	*Coturnix coturnix*	Commom Quail		
		Arborophila crudigularis	Formosan Hill Partridge	••	C
		Bambusicola thoracica	Bamboo Partridge	•	C
		Lophura swinhoii	Swinhoe's Blue Pheasant	••	E
		Syrmaticus mikado	Mikado's Pheasant	••	E
Gruiformes	Rallidae	*Amaurornis phoenicurus*	White-breasted Waterhen		C
Columbiformes	Columbidae	*Treron sieboldi*	Japanese Green Pigeon		C
		Columba pulchricollis	Ashy Wood Pigeon		C
		Chalcophaps indica	Emerald Dove		C
Cuculiformes	Cuculidae	*Centropus bengalensis*	Lesser Coucal		C
Strigiformes	Strigidae	*Otus spilocephalus*	Mountain Scops Owl		C
		Glaucidium brodiei	Pygmy Owl		C
Apodiformes	Apodidae	*Apus pacificus*	White-rumped Swift		
		Apus affinis	House Swift		C
Piciformes	Capitonidae	*Megalaima oorti*	Muller's Barbet	•	C
	Picidae	*Dendrocopos leucotos*	White-backed Woodpecker	•	C
		Dendrocopos canicapillus	Pigmy Woodpecker	•	C
Passeriformes	Hirundinidae	*Riparia paludicola*	Brown-throated Sand Martin		C
		Hirundo tahitica	Pacific Swallow		C
	Motacillidae	*Motacilla flava*	Yellow Wagtail		C
		Motacilla alba	White Wagtail		C
		Anthus cervinus	Red-throated Pipit		C
	Campephagidae	*Coracina novaehollandiae*	Large Cuckoo-shrike		C
		Pericrocotus solaris	Grey-throated Minivet		C

Table 9. (cont.)

Order	Family	Species	Common Name	Endemic	Status
Passeriformes	Pycnonotidae	*Spizixos semitorques*	Finch-billed Bulbul	•	C
		Pycnonotus taivanus	Styan's Bulbul	••	C
		Hypsipetes amaurotris	Brown-eared Bulbul	•	
		Hypsipetes madagascariensis	Black Bulbul	•	C
	Oriolidae	*Oriolus traillii*	Maroon Oriole	•	E
	Dicruridae	*Dicrurus aeneus*	Bronzed Drongo	•	C
	Corvidae	*Garrulus glandarius*	Jay	•	C
		Urocissa caerulea	Formosan Blue Magpie	••	C
		Crypsirina formosae	Gray Treepie	•	C
		Corvus macrorhynchus	Large-billed Crow		C
	Cinclidae	*Cinclus pallasii*	Brown Dipper		C
	Troglodytidae	*Troglodytes troglodytes*	Wren	•	C
	Turdidae	*Brachypteryx montana*	Blue Shortwing	••	C
		Rhyacornis fuliginosus	Plumbeous Water Redstart	•	C
		Cinclidium leucurum	White-tailed Blue Robin	•	C
		Enicurus scouleri	Little Forktail		
		Monticola solitaria	Blue Rock Thrush		C
		Myiophoneus insularis	Formosan Whistling Thrush	••	C
		Turdus obscurus	Grey-headed Thrush	•	C
	Timaliidae	*Pomatorhinus erythrogenys*	Rusty-cheeked Scimitar Babbler	•	C
		Pomatorhinus ruficollis	Lesser Scimitar Babbler	•	C
		Stachyris ruficeps	Red-headed Babbler	•	C
		Garrulax albogularis	White-throated Laughing Thrush	•	C
		Garrulax poecilorhynchus	Grey-sided Laughing Thrysh	•	C
		Garrulax morrisonianus	Formosan Laughing Thrush	••	C
		Liocichla steerii	Steere's Babbler	••	C
		Alcippe cinereiceps	Brown-headed Nun Babbler	•	C
		Alcippe brunnea	Gould's Nun Babbler	•	C
		Alcippe morrisonia	White-eyed Nun Babbler	•	C
		Heterophasia auricularis	White-eared Sibia	••	C
		Yuhina brunneiceps	Formosan Yuhina	••	C

Table 9. (cont.)

Order	Family	Species	Common Name	Endemic	Status
Passeriformes	Timaliidae	*Yuhina zantholeuca*	White-bellied Yuhina		C
	Paradoxornithidae	*Paradoxornis nipalensis*	Orange Parrotbill	•	C
	Sylviidae	*Cettia squameiceps*	Short-tailed Bush Warbler		R
		Cettia acanthizoides	Yellow-bellied Bush Warbler	•	C
		Seicercus albogularis	Fulvous-faced Flycatcher Warbler		C
	Muscicapidae	*Niltava vivida*	Rufous-bellied Blue Flycatcher	•	C
		Muscicapa ferruginea	Ferruginous Flycatcher		C
		Hypothymis azurea	Black-naped Blue Flycatcher	•	C
	Paridae	*Parus monticolus*	Green-backed Tit	•	C
		Parus holsti	Yellow Tit	••	C
		Aegithalos concinnus	Red-headed Tit		C
	Sittidae	*Sitta europaea*	Nuthatch		C

•• Endemic species
• Endemic subspecies
R Rare
C Common
E Endangered (listed to be protected under the Culture Heritage Preservation Act)

Table 10. Amphibian species found in Tawu Mountain Nature Reserve based on surveys from March, 1987 to December, 1988.

Order	Family	Species	Common Name	Endemic	Status
Anura	Bufonidae	*Bufo bufo*			C
		Bufo melanostictus	Spectacled Toad		C
	Rhacophoridae	*Rhacophorus moltrechti*		**	C
		Rhacophorus robustus		**	C
		Rhacophorus japonicus			C
		Rhacophorus eiffingeri			C
	Ranidae	*Rana narina*			C
		Rana latouchi			C
		Rana sauteri			C

** Endemic species
C Common

Table 11. Reptile species found in Tawu Mountain Nature Reserve based on surveys from March, 1987 to December, 1988.

Order	Family	Species	Common Name	Endemic	Status
Squamata	Viperidae	*Agkistrodon acutus*	Hundred-pace Snake		E
		Trimeresurus gramineus	Bamboo Snake		C
	Elapidae	*Naja naja*	Common Cobra		C
	Colubridae	*Dinodon rufozonatum*	Red Banded Snake		C
		Dinodon septentrionale	White Plum Blossom Snake	*	C
		Natrix percarinata	White-stomach Snake	*	C
		Natrix sauteri	Sauter's Water Snake		C
		Eurypholis major	Taiwan Green Snake		C
		Enhydris plumbea	Common Rice Paddy Snake		C
		Elaphe taeniura	Taiwan Beauty Snake		C
		Elaphe carinata	Taiwan Stink Snake		C
		Zaocys dhumnades	Big-Eye Snake		C
	Gekkonidae	*Gekko japonicus*	Gecko		C
	Agamidae	*Japalura mitsukurii*		**	C
	Lacertidae	*Takydromus sauteri*		**	C
	Scincidae	*Sphenomorphus indicus*			C
		Eumeces elegans	Elegant Skink		C
	Anguidae	*Ophisaurus harti*	Legless Lizard		C

** Endemic species
* Endemic subspecies
C Common
E Endangered (listed to be protected under the Culture Heritage Preservation Act)

Table 12. Fish species found in Tawu Mountain Nature Reserve based on surveys from March, 1987 to December, 1988.

Order	Family	Species	Common Name
Cypriniformes	Cyprinidae	*Cyprinus carpio(?)*	Common Carp
		Varicorhinus tamusuiensis	
	Homalopteridae	*Hemimyzon spp.*	
Anguilliformes	Anguillidae	*Anguilla marmorata*	Swamp Eel
Perciformes	Gobiidae	*Awaous ocellaris*	
		Sicyopterus japonicus	

Table 13. Butterfly species found in Tawu Mountain Nature Reserve based on surveys from January, 1988 to December, 1988.

Family	Species
Papilionidae	*Graphium doson postianum*
	Graphium sarpedon connectens
	Papilio bianor takasago
	Papilio nephelus chaonulus
	Papilio polytes pasikrates
	Papilio thaiwanus
	Troides aeacus kaguya
Pieridae	*Appias lyncida formosana*
	Catopsilia pyranthe pyranthe
	Delias pasithoe curasena
	Eurema hecabe hobsoni
	Ixias pyrene insignis
	Pieris canidia canidia
	Hebomoia glaucippe formosana
Danaidae	*Euploea sylvester swinhoci*
Satyridae	*Elymnias hypermnestra hainana*
	Lethe verma cintamani
	Melanitis leda leda
	Mycalesis francisca formosana
Nymphalidae	*Yoma sabina vasuki*
	Athyma cama zoroastes
	Hestina assimilis formosana
	Hypolimnas bolina kezia
	Sephisa chandra androdamas
	Sumalia dudu jinamitra
	Cyrestis thyodamas formosana
	Symbrenthia avanus formosanus
	Precis almana almana

Table 14. Potential bird species which may be found in Tawu Mountain Nature Reserve but not listed in Table 9 (based on Chang, 1985).

Order	Family	Species	Common Name	Endemic	Status
Falconiformes	Accipitridae	*Milvus korschun*	Black Kite		C
		Accipiter soloensis	Chinese Goshawk		
		Accipiter virgatus	Asiatic Sparrow Hawk	•	C
		Butastur indicus	Gray-faced Buzzard		C
		Ictinaetus malayensis	Black Eagle		E
		Circus aeruginosus	Marsh Harrier		C
Galliformes	Phasianidae	*Coturnix chinensis*	Painted Quail		C
		Phasianus colchicus	Ring-necked Pheasant	•	
Gruiformes	Turnicidae	*Turnix sylvatica*	Little Button Quail		C
		Turnix suscitator	Barred Button Quail	•	C
	Rallidae	*Porzana fusca*	Ruddy Crake		C
		Amaurornis phoenicurus	White-breasted Water-hen		C
Charadriiformes	Scolopacidae	*Numenius spp.*	Whimbrel		C
		Tringa hypoleucos	Common Sandpiper		C
Columbiformes	Columbidae	*Treron formosae*	Red-capped Green Pigeon		
		Streptopelia orientalis	Eastern Turtle Dove	•	C
		Streptopelia chinensis	Spotted-necked Dove	•	C
		Streptopelia tranquebarica	Red Turtle Dove		C
Cuculiformes	Cuculidae	*Cuculus sparverioides*	Large Hawk Cuckoo		C
		Cuculus saturatus	Blyth's Cuckoo		C
		Cuculus pollocephalus	Little Cuckoo		C
Strigiformes	Tytonidae	*Tyto capensis*	Chinese Grass Owl		
	Strigidae	*Otus bakkamoena*	Collard Scops Owl		C
		Ketupa ketupa	Tawny Fish Owl		E
		Ninox scutulata	Brown Hawk Owl		C
		Strix aluco	Tawny Wood Owl		E
Caprimulgiformes	Caprimulgidae	*Caprimulgus affinis*	Savanna Nightjar		C
Coraciiformes	Alcedinidae	*Alcedo atthis*	Common Kingfisher		C
Piciformes	Picidae	*Picus canus*	Black-naped Woodpecker	•	
Passeriformes	Alaudidae	*Alauda gulgula*	Lesser Skylark		C

Table 14. (cont.)

Order	Family	Species	Common Name	Endemic	Status
Passeriformes	Hirundinidae	*Delichon urbica*	House Martin		C
		Hirundo daurica	Red-rumped Swallow		C
	Motacillidae	*Motacilla cinerea*	Grey Wagtail		C
		Anthus hodgsoni	Tree Pipit		C
	Laniidae	*Lanius cristatus*	Brown Shrike		C
		Lanius schach	Rufous-backed Shrike	•	C
	Oriolidae	*Oriolus chinensis*	Black-naped Oriole		R
	Dicruridae	*Dicrurus macrocercus*	Black Drongo	•	C
	Sturnidae	*Sturnus philippensis*	Red-cheeked Starling		C
		Acridotheres cristatellus	Crested Myna	•	C
	Corvidae	*Nucifraga caryocatactes*	Nutcracker	•	
	Prunellidae	*Prunella collaris*	Alpine Accentor	•	C
	Turdidae	*Luscinia calliope*	Ruby-throat		C
		Tarsiger johnstoniae	Johusten's Bush Robin	••	C
		Zoothera dauma	Golden Mountain Thrush		C
		Turdus poliocephalus	Island Thrush	••	R
		Turdus chrysolaus	Brown Thrush		C
		Turdus naumanni	Dusky Thrush		C
	Timaliidae	*Pnoepyga pusilla*	Pygmy Wren Babbler	•	
		Garrulax canorus	Hwamei	•	
		Actinodura morrisoniana	Formosan Barwing	••	C
	Paradoxornithidae	*Paradoxornis webbiana*	Vinous-throated Parrotbill	•	C
	Sylviidae	*Cettia diphone*	Bush Warbler		C
		Cettia fortipes	Mountain Bush Warbler	•	C
		Bradypterus seebohmi	Brown Bush Warbler		C
		Phylloscopus borealis	Arctic Willow Warbler		C
		Regulus goodfellowi	Firecrest	••	C
		Cisticola juncidis	Stresked Fantail Warbler		C
		Cisticola exilis	Pale-headed Fantail Warbler	•	C
		Prinia subflava	Tawny Wren Warbler	•	C

Table 14. (cont.)

Order	Family	Species	Common Name	Endemic	Status
Passeriformes	Sylviidae	*Prinia flaviventris*	Yellow-bellied Wren Warbler		C
		Prinia polychroa	Hill Warbler	•	C
	Muscicapidae	*Ficedula hyperythra*	Rufous-breasted Blue Flycatche:	•	
		Muscicapa ferruginea	Ferruginous Flycatcher		C
	Paridae	*Parus ater*	Coal Tit	•	C
		Parus varius	Varied Tit	•	R
	Dicaeidae	*Dicaeum concolor*	Plain Flowerpecker	•	C
		Dicaeum ignipectus	Fire-breasted Flowerpecker	•	C
	Zosteropidae	*Zosterops japanica*	Chinese White Eye		C
	Ploceidae	*Passer rutilans*	Russet Sparrow		C
		Lonchura striata	Sharp-tailed Munia		C
		Lonchura punctulata	Spotted Munia		C
		Lonchura malacca	Chestnut Munia	•	C
	Fringillidae	*Carduelis spinus*	Siskin		C
		Carpodacus vinaceus	Vinaceous Rose Finch	•	C
		Pyrrhula nipalensis	Brown Bullfinch	•	C
		Pyrrhula erythaca	Beavan's Bullfinch	•	C
		Emberiza spodocephala	Black-faced Bunting		C
		Emberiza sulphurata	Yellow Bunting		C

•• Endemic species
• Endemic subspecies
R Rare
C Common
E Endangered (listed to be protected under the Culture Heritage Preservation Act)

Table 15. Some characteristics of the western buffer zone of Tawu Mountain Nature Reserve.

Habitat Type	Total Area (ha)	%	Elevation (m)	Slope	Soil Depth (cm)	Age of Trees (yr)	Dominant Tree Species
Natural Broad-leaved Forest	4931.78	23.03	900-2100	6°-45°	30-60	1-80	*Persea sp.* *Castanopsis sp.* *Cyclobalanopsis sp.*
Natural Conifer and Broad-leaved Mixed Forest	5667.51	26.47	1200-2500	23°-45°	30-60	31-120	*Tsuga chinensis* *Chamaecyparis formosensis* *Pinus sp. Persea sp.*
Rocky Open Area	5096.03	23.80	500-2700	6°-45°	--	--	
Broad-leaved Plantation	2013.08	9.40	900-2800	23°-45°	30-60	--	
Broad-leaved and Conifer Mixed Plantation	2914.56	13.61	500-2700	6°-45°	30-60	--	
Bamboo Forest	508.51	2.37	1000-2700	23°-45°	30-60	--	
Grassland	57.50	0.27	1000-2700	23°-45°	30-60	--	
Logged area	231.24	1.08	--	--	--	--	

Appendix I. Declaration of Tawu Mountain Nature Reserve (In Chinese).

最速件

行政院農業委員會
經濟部　公告

日期：中華民國七十七年一月十三日

文號：七十七農林字六○三○二○九八號
經（七七）分○一○四九號

附件：如文

收受者：行政院秘書處、行政院國軍退除役官兵輔導委員會、行政院經濟建設委員會、行政院文化建設委員會、行政院衛生署、行政院環境保護署、內政部、教育部、交通部、台灣省政府秘書處、民政廳、教育廳、建設廳、農林廳、交通處、警務處、水利局、林務局、糧食局、山地農牧局、林業試驗所、台北市政府、高雄市政府、經濟部秘書室（請刊登公報）、經濟部法規委員會、台北、桃園、新竹、苗栗、台中、彰化、雲林、嘉義、台南、高雄、屏東、台東、花蓮、宜蘭、南投、澎湖等縣政府、基隆、新竹、台中、嘉義、台南等市政府（均含附件）

主　旨：公告大武山自然保留區。

依　據：文化資產保存法第四十九條暨其施行細則第七十二條。

公告事項：

一、名稱：大武山自然保留區。

二、主要保護對象：野生動物及其棲息地、原始林、高山湖泊。

三、面積：四七，○○○公頃。

四、位置：大武事業區第二、三、四、五、六、七、八、九、十、十二、十三、十四、十五、十六、十七、十八、十九、二十、廿四、廿五、廿六、廿七、廿八、廿九、三十林班，台東事業區第十八、十九、二十、廿一、廿二、廿三、廿四、廿五、廿六、卅五、卅六、卅七、卅八、卅九、四十、四十二、四十三、四十五、四十六、四十七、四十八、四十九、五十林班及第四十一、五十一兩林班扣除墾植用地以外之土地，台東縣界內屏東林區管理處之巴油池及附近縣界以東之林地。

五、管理機關：台灣省政府農林廳林務局

六、注意事項：

(一)生態保育區與自然保留區，禁止改變或破壞其原有自然狀態。（文化資產保存法第五十二條）。

(二)珍貴稀有動植物禁止捕採、獵捕、採摘、砍伐或其他方式予以破壞，並應維護其生態環境。但研究機構為研究、陳列或國際交換需特殊需要，報經主管機關核准者不在此限。（文化資產保存法第五十三條）

(三)自然文化景觀所在地區域計畫、都市計畫之訂定或變更，應先徵求自然文化景觀主管機關之意見。（文化資產保存法第五十四條第一項）

(四)珍貴稀有動植物，除依本法第五十三條但書核准之研究或國際交換外，一律禁止出口。

前項禁止出口項目包括珍貴稀有動植物標本及其他取材於珍貴稀有動植物之加工品。（文化資產保存法施行細則第七十六條）

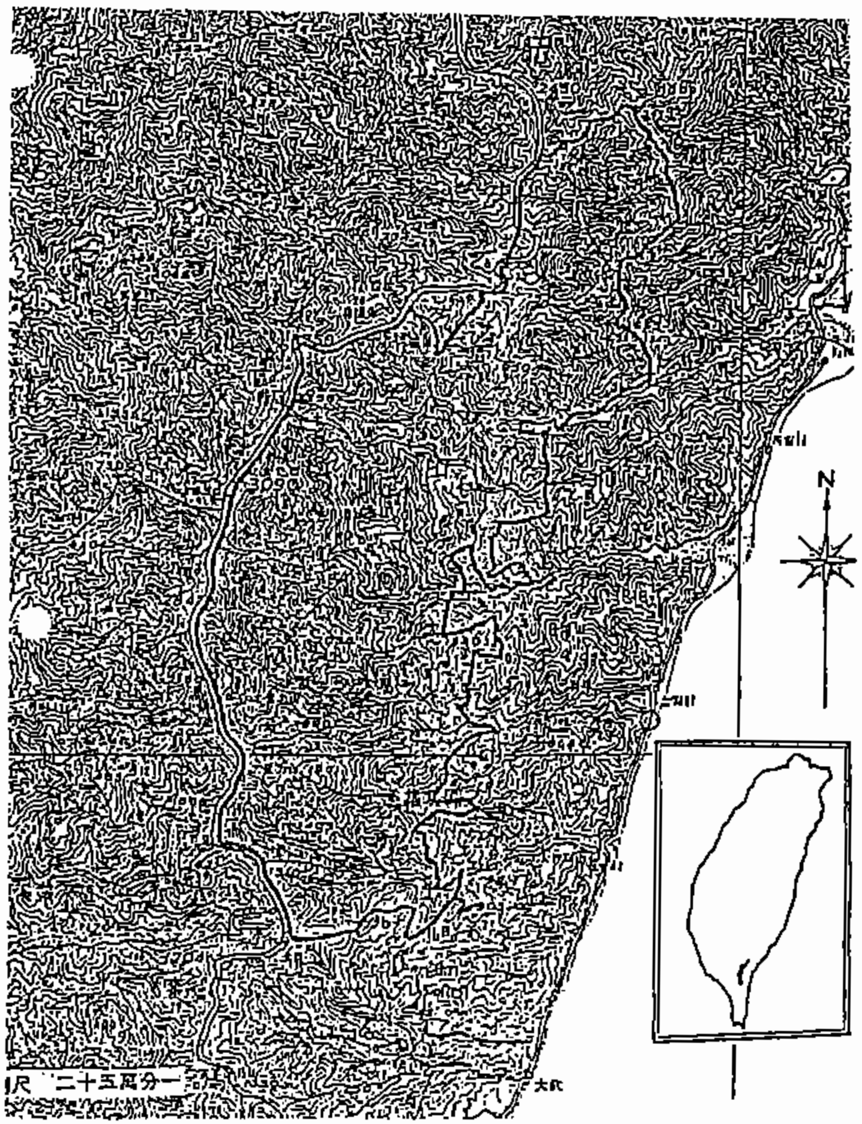
(五)改變或破壞自然文化景觀者，處五年以下有期徒刑，拘役或科或併科三

萬元以下罰金。（文化資產保存法第五十五條第六款）

㈥捕獵、網釣、採摘、砍伐或破壞指定之珍貴稀有動植物者，處三年以下有期徒刑，拘役或科或併科二萬元以下罰金。（文化資產保存法第五十六條第二款）。

附件：大武山自然保留區範圍圖影本乙份。

大武山自然保留區範圍圖



Appendix II. Meeting of COA and TFB about buffer zone status and its management by TFB (In Chinese).

五、主席報告：（略）

六、報告事項：（略）

七、討論事項：

大武山自然保留區之劃定及公告作業。

決議：㈠自然保留區範圍以關山林區管理處轄約四萬六千公頃林班為原則，由林業處詳加描繪於五千或一萬分之一航照圖，並先徵詢林務局同意。並請林務局及林務局[?]研究停止保留區內林產之處分及新舊租地撥還[?]之可行性。

㈡大武山西側屏東林區管理處轄大武山區林班地雖不劃入保留區範圍，其土地可依現有之利用型態繼續經營使用，但非依法定程序不得變更使用方式或擴大面積，以發揮保留區周邊緩衝區域功能。

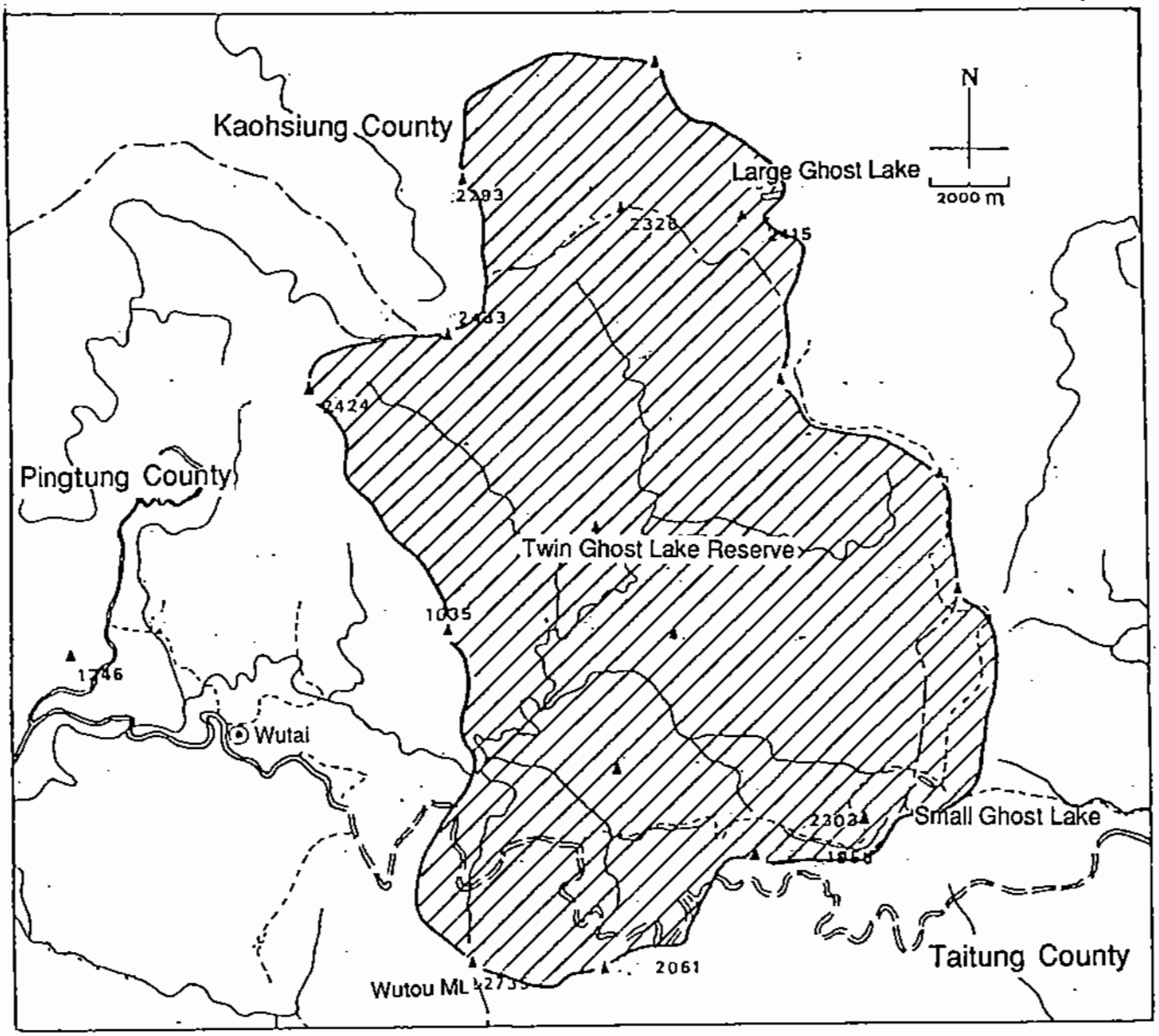
㈢請林務局關山及屏東兩林管處儘速研擬[?]管理維護計畫，並函送本會。

㈣請台東縣政府暫緩辦理大武山預定保留區範圍內比魯溫泉之規劃及開發工作

八、臨時動議：（略）

九、散會。

Appendix III. Map of proposed Twin Ghost Lake Reserve (Based on Chang *et al.* 1985 ' A survey report on the potential species and regions of biological importance in Taiwan').



Appendix IV. Status of forest land within Tawu Mountain Nature Reserve (In Chinese).

大武山自然保留區之林地現況

一、「大武山自然保留區」經行政院農委會核定實施，其範圍含台東事業區第41—50林班，大武事業區第2—10、12—22林班合計32個林班面積約三萬公頃。農委會於民國七十六年九月三日將大武山區保留區範圍予以擴大，其預定擴大之範圍含台東21—25、35—40林班及大武24—29林班合計18個林班面積約一三五〇〇公頃，總計「大武山自然保留區」本處轄區共有50個林班面積約四三五〇〇公頃。

二、林地現況：

(1)造林地情形

本保育區範圍（包括擴大部份）：大武13—19林班，24—29林班及台東21—25林班均有歷年造林地，惟近期無任何造林措業，爾後應配合自然保育區計劃辦理。

(2)伐木情形：

大武14林班於五十八年伐木面積一五〇公頃，大武15林班於六十三年伐木，面積一〇八公頃，合計二五八公頃，均已完成造林工作，惟台東區38、39林班面積五六五公頃國家森林管理處為九四三三〇m³係編列十年伐木計劃（至民國八十年止）指定施業區，若予編入保護區勢必影響該區經營計劃。

(3)副產物處分情形：

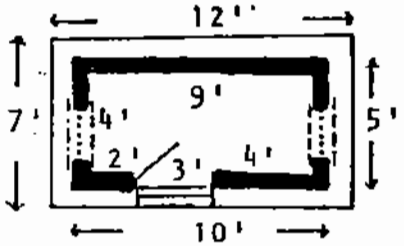
大武事業區第9、10、13、20、24林班原皆採取礦石，採取日期自76年4月10日至81年4月9日計五年，為配合動物保育區之設立自77年度起停止礦石之採取。

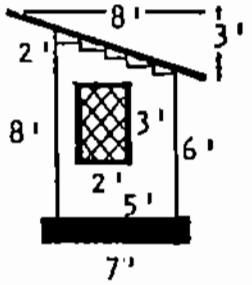
(4)礦業用地出租情形：

(1)台東41林班弘杰礦業股份有限公司一公頃一三，自74年4月4日至78年4月3日。(2)台東41林班弘杰礦業股份有限公司〇公頃八〇自75年5月1日至77年5月20日。(3)台東41林班蔡秀山〇公頃五〇，自75年5月5日至77年5月4日止合計三筆二公頃四三，因礦業用地使用林地面積較小且關係人民權益至鉅，除保持現狀外，爾後不再核租供採礦使用。

(5)租地造林地及遊憩區地情形：「大武山自然保留區」及擬定擴大範圍內均無租地造林地及遊憩區地。

Appendix V. (a) Gatehouse and (b) patrol outpost structures (From Teleki, 1986).

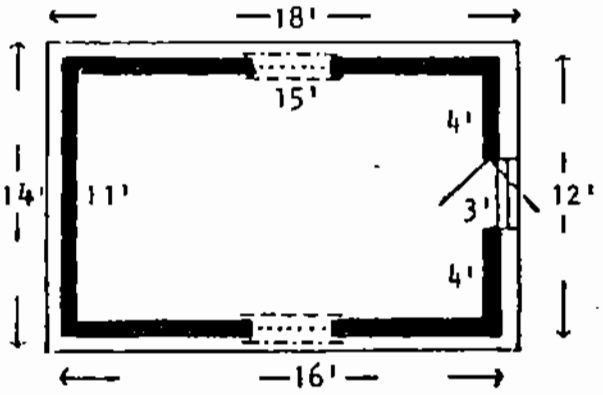


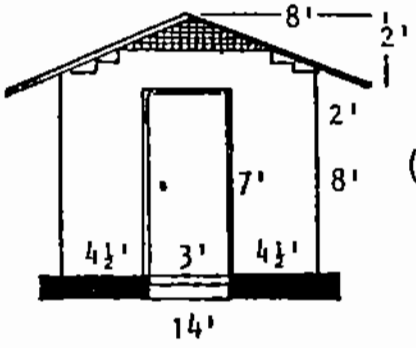


(a)

MATERIALS:

Bricks	=	430
Floor	=	36 ft^2
Foundation	=	30 ft
Zinc sheets 8'	=	3
Trusses	=	-
Mesh windows 2''	=	2
Screens	=	2
Shutters	=	2
Wooden doors	=	1
Screen doors	=	1



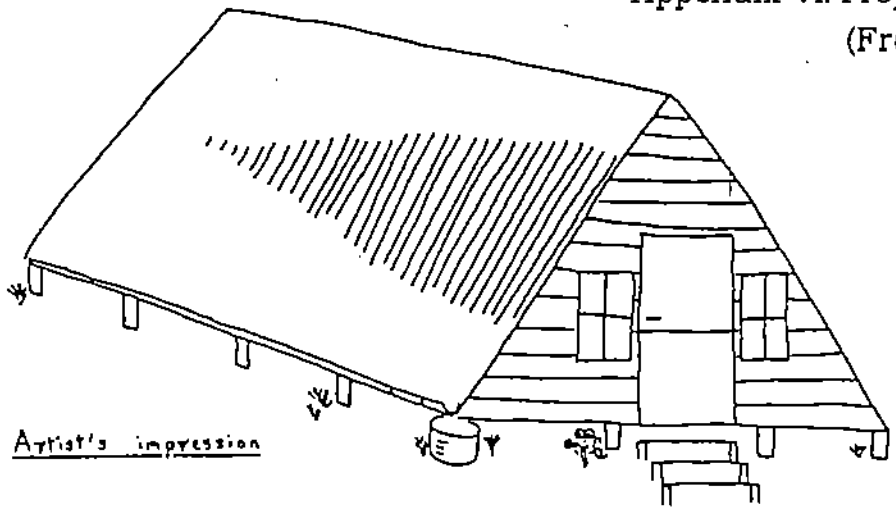


(b)

MATERIALS:

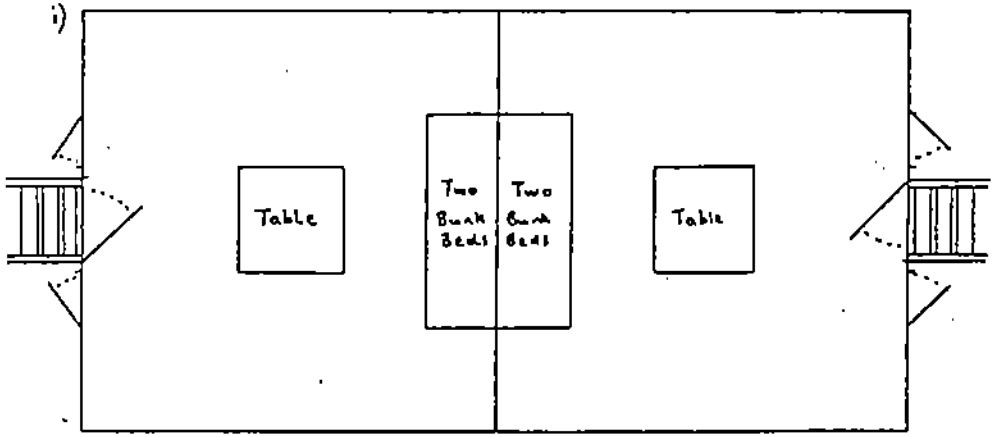
Bricks	=	1,200
Floor	=	165 ft^2
Foundation	=	60 ft
Zinc sheets 8'	=	10
Trusses	=	6
Mesh windows 2''	=	2
Screens	=	2
Shutters	=	2
Wooden doors	=	1
Screen doors	=	1

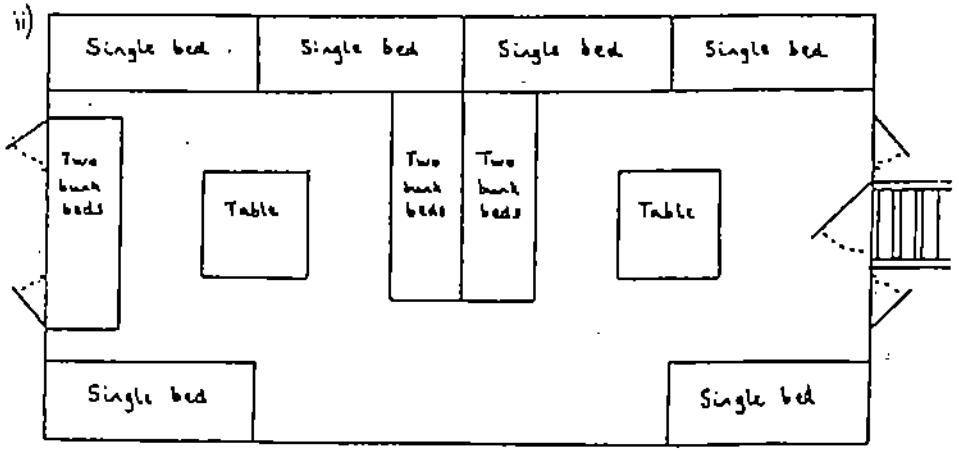
Appendix VI. Proposed backcountry gatehouse or monitoring station (From Hillman, 1986).



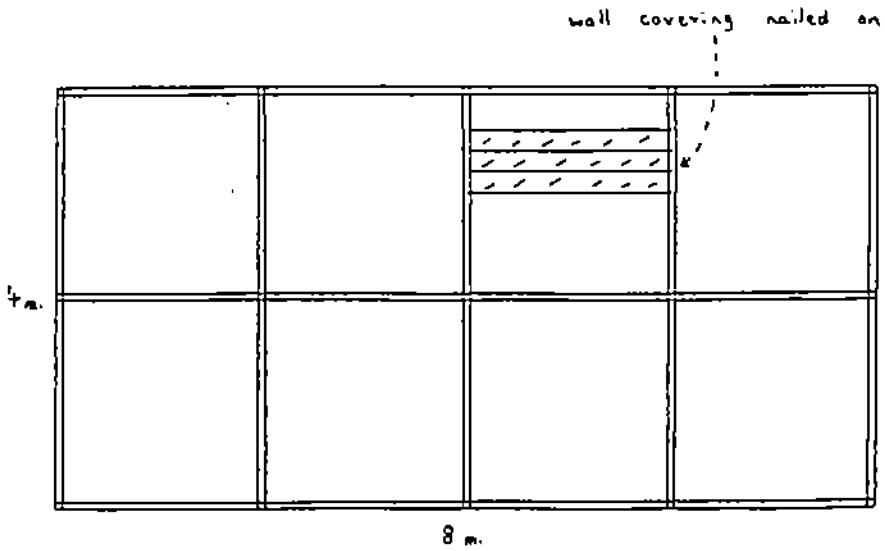
Artist's impression

Internal layout – i) Game Scouts
ii) Tourists



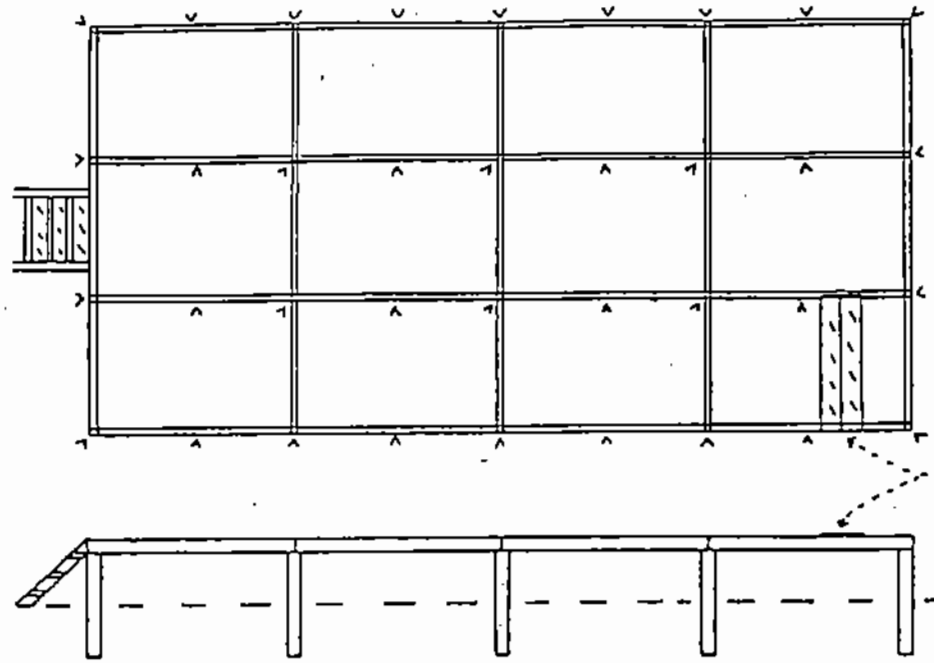


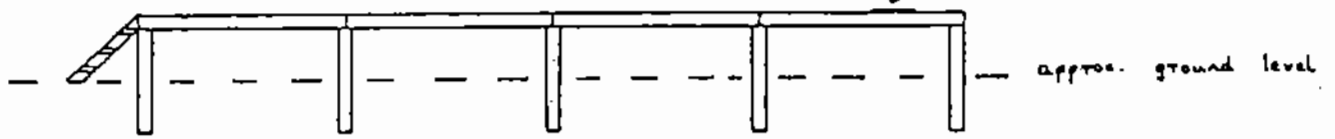
Side wall/roof (covered in corrugated iron over planks)



Plan of floor framework

framework 8 x 12 cm.
floor covering 2 x 20 cm.
(x) support posts 12 x 12 x 100 cm.

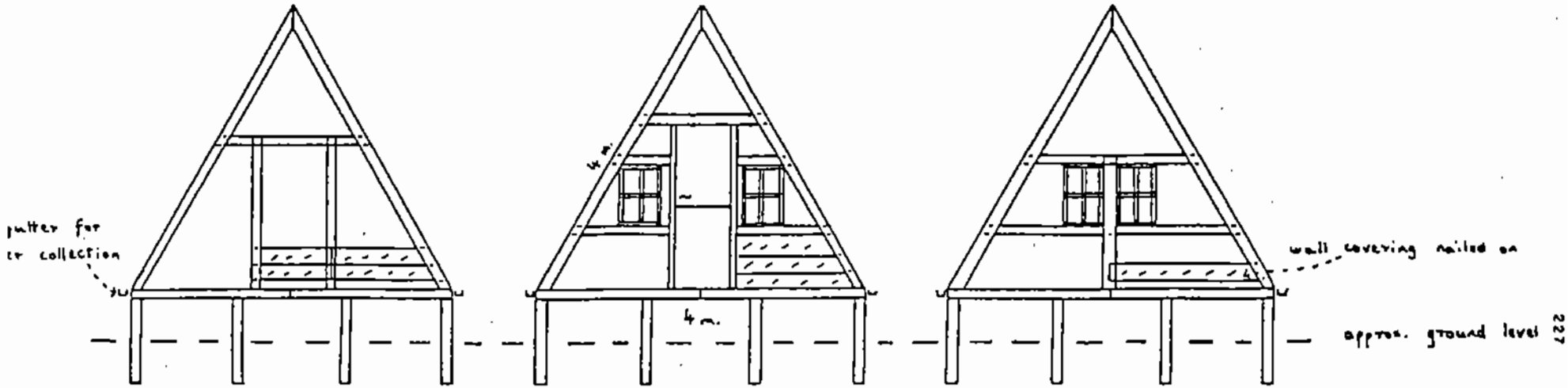




Centre wall with door space

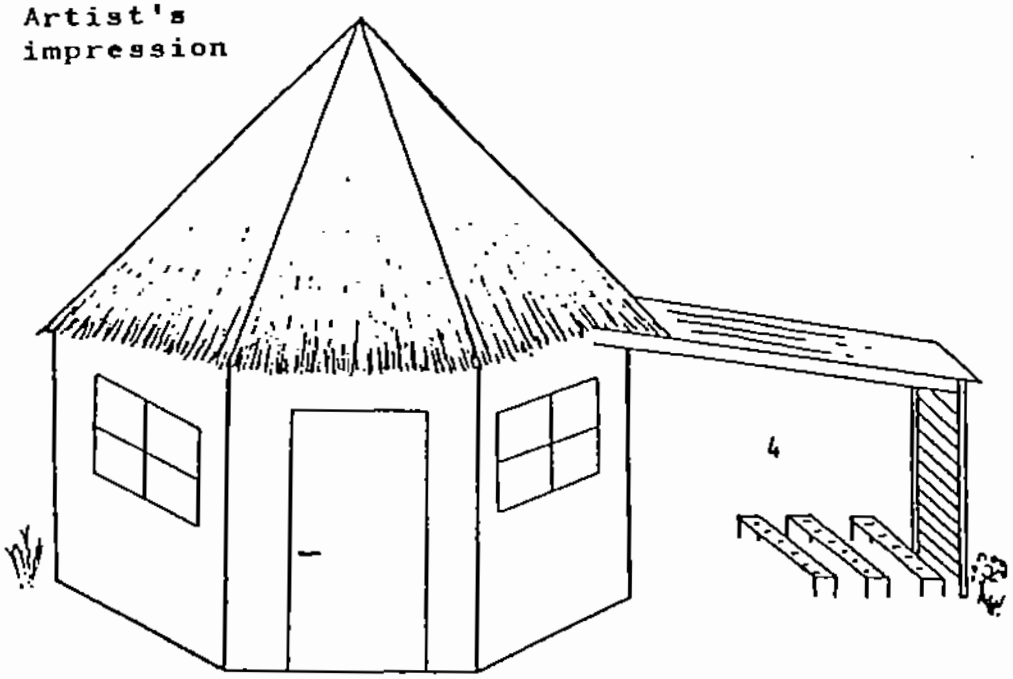
End wall, windows and door

End wall, windows only



Appendix VII. Proposed museum and education center structures
(From Hillman, 1986)

i) Artist's impression



ii) Floor plan

1. Storage, library, herbarium etc.
2. Tableau area
3. Hinged display boards
4. Outside education area