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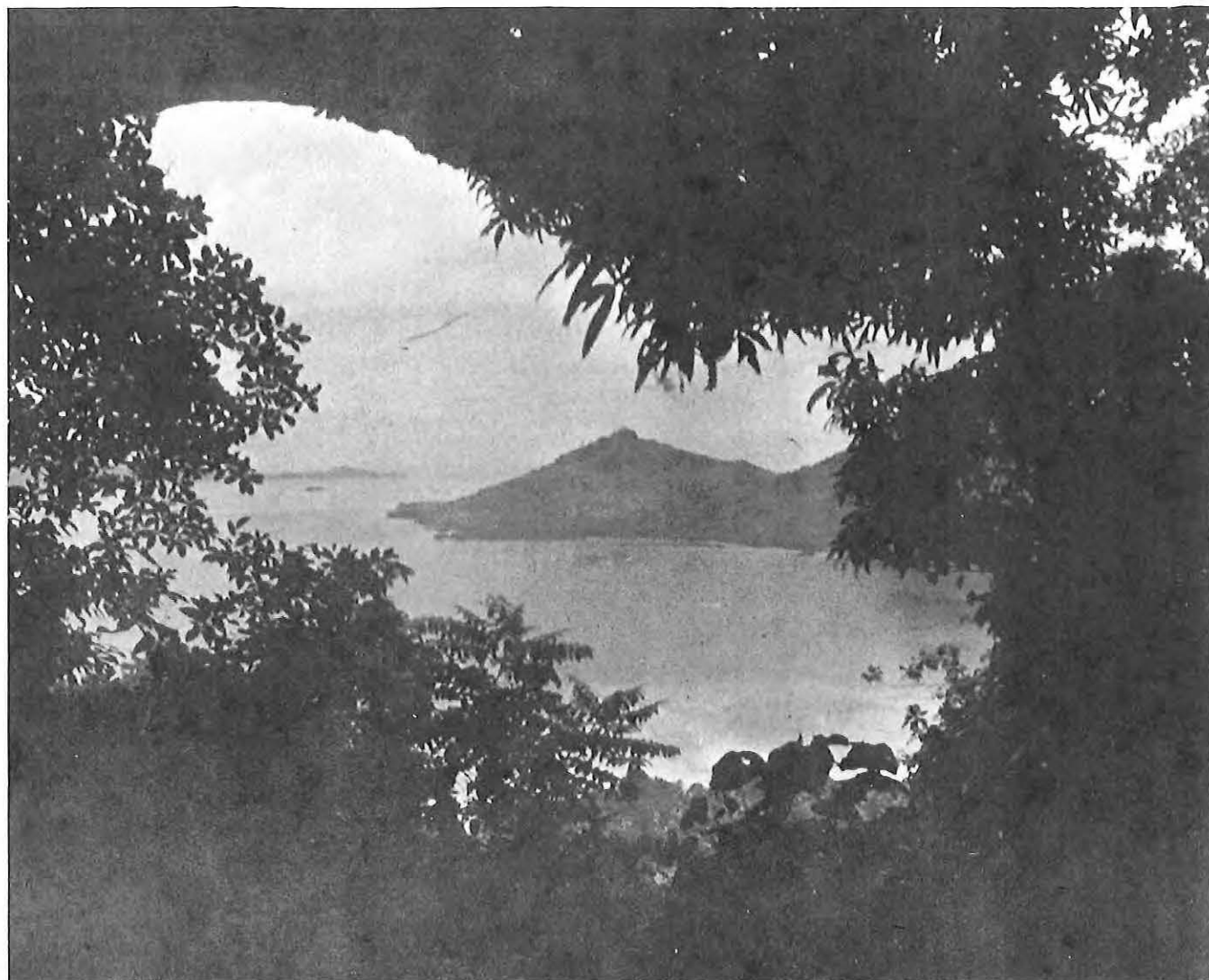
Resource Bulletin
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Vegetation Survey of Moen, Dublon, Fefan, and Eten, State of Truk, Federated States of Micronesia

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INTRODUCTION

Truk is one of the four States of the Federated States of Micronesia (FSM). Knowledge of the extent and composition of its vegetation, including forest land, is needed for land-use planning. To fill this need, a formal agreement was drawn up between the High Commissioner of the Trust Territory of the Pacific Islands and two agencies of the U.S. Department of Agriculture—the Soil Conservation Service and the Forest Service, to map the vegetation of Truk. Three vegetation maps were prepared by the Forest Service in cooperation with the Government of the State of Truk, for land-use planning and to provide a basis for forest surveys.

This bulletin summarizes the vegetation for four of the islands of Truk, presents the three vegetation maps, and describes the vegetation types, their ecological function, and uses. A breakdown of nonforest types is also provided.

GEOGRAPHY AND CLIMATE

The State of Truk consists of a group of partially sunken volcanic islands surrounded by a barrier reef about 63 km (39 statute mi) in diameter and a number of coral atolls and islands outside the barrier reef, located about 5,713 km (3,550 statute mi) southwest of Hawaii (fig. 1). The islands mapped in this survey include only the four islands of Dublon, Fefan, Moen, and Eten,

which lie within the Truk Lagoon at lat. 7°45' N and long. 151°52' E, in the North Pacific Ocean (fig. 1). A lack of current aerial photography precluded the inclusion of Tol and other islands of Truk in this survey.

The combined land area of the four islands surveyed is 4,170 hectares (10,305 acres) (table 1). The islands are characterized by steep uplands, which comprise about 73 percent of the total land area. The maximum elevation on Moen Island is Mt. Tonoken, which is 370 m (1,214 ft). On Dublon, Mt. Tonomwan rises to 344 m (1,128 ft), and on Fefan, the highest point is Mt. Ipar or Mt. Iron at 300 m (984 ft). Mt. Tumuital on Tol Island is the highest point [443 m (1,453 ft)] in the State of Truk.

Truk has the largest population of the four states in the FSM—about 45,000 people (1980 census). It also has the highest percentage of agroforest; over 50 percent of the land area of the mapped islands (table 1, fig. 2) is classed as agroforest.

The climate of Truk is hot and humid. Mean annual rainfall measured on Moen is about 3,650 mm (144 in). The driest months are January through March, with an average monthly rainfall below 210 mm (9 in). Occasionally, the dry season is severe. Mean annual temperature is 27 °C (81 °F) with less than 1 °C (2 °F) difference between the warmest and coolest months of the year. Humidity is high throughout the year, averaging 75 to 85 percent.

The islands of Truk generally lie outside the main typhoon belt, however, they have been affected by a number of typhoons in recent years. The most destructive occurred in 1971, when Typhoon Amy caused a significant amount of damage to buildings and agricultural crops.

Truk's dense human population has greatly modified the island's native vegetation. Population pressure has destroyed much of the native forest. Remnants of these forests on the mountain-tops of Moen, Dublon, and Fefan contain a number of endemic species—all that is left of what must have once been an extensive

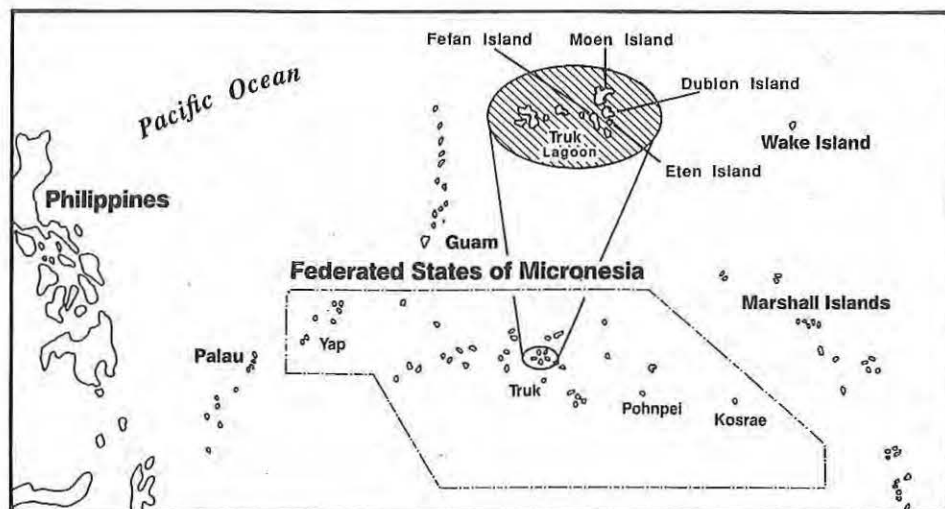


Figure 1 — The State of Truk, Federated States of Micronesia, consists of 90 islands and atolls. Current aerial photographs were available for only Moen, Dublon, Fefan and Eten — the four islands surveyed.

native flora. Most of the lower slopes of these islands have been converted to coconut-breadfruit agroforest.

Scientists with the Soil Conservation Service (SCS) have mapped and described nine soil series and variants on Truk and provided soil management guidelines (Laird 1983).

Breadfruit and copra production, and some subsistence farming are the main agricultural enterprises on Truk. The main subsistence crops are breadfruit, coconuts, bananas, and taro. The local economy is also supported by fishing, handicrafts, and government employment.

Table 1—Summary of area by land class and type for Moen, Dublon, Fefan, and Eten Islands, Truk State, Federated States of Micronesia, 1976

Land class and type	Area by island				Total
	Moen	Dublon	Fefan	Eten	
	<i>Hectares (acres)</i>				
Forest					
Upland	360	76	232	9	677 (1,673)
Mangrove	149	69	88	—	306 (757)
Palm	—	—	2	—	2 (6)
Plantation	1	—	—	—	1 (2)
Total forest	510	145	322	9	986 (2,438)
Secondary vegetation	165	35	52	—	252 (622)
Agroforest					
Agroforest	11	15	40	—	66 (164)
Agroforest, coconuts	847	738	692	35	2,312 (5,713)
Total agroforest	858	753	732	35	2,378 (5,877)
Nonforest					
Strand	<1	—	5	—	5 (13)
Marsh	125	62	47	—	234 (578)
Grassland	84	6	79	5	174 (429)
Cropland	<1	1	2	—	3 (7)
Urban	108	6	15	—	129 (319)
Barren	5	—	<1	—	5 (13)
Water	3	1	—	—	4 (9)
Total nonforest	325	76	148	5	554 (1,368)
Total area	1,858	1,009	1,254	49	4,170 (10,305)

Table 2—Combined area of forest land by size and density classes, for Moen, Dublon, Fefan, and Eten, 1976

Type	Size class ²	Density class ¹			Total
		Low	Medium	High	
		<i>Hectares (acres)</i>			
Upland forest	1	0	465	212	677 (1,673)
Mangrove	0	0	0	44	44 (109)
Mangrove	1	1	0	261	262 (648)
Palm forest	1	0	0	2	2 (6)
Plantation forest	1	0	0	1	1 (2)
Total forest					986 (2,438)

¹Crown closure of main canopy: low less than 30 pct; medium 30–70 pct; high greater than 70 pct.

²0—Short, shrub-like trees smaller than 12.5 cm (5 in) in d.b.h.

1—Trees averaging less than 30 cm (12 in) in d.b.h. but larger than 12.5 cm (5 in) in d.b.h.

2—Trees averaging 30 cm (12 in) or more in d.b.h.

SURVEY METHODS

Truk's vegetation types were delineated on black and white aerial photography taken in 1976 at a scale of 1:10,000. Updating the photography for change since 1976 was not feasible. Vegetation types were identified by examining the photos stereoscopically for differences in tone, texture, and pattern. In some cases individual species were recognized by their distinctive shape.

Before vegetation typing could begin, a vegetation mapping scheme was needed. Because the islands are inaccessible by road, and funds were limited, vegetation types were restricted to those easily interpreted without extensive ground checking.

After preliminary field reconnaissance, the classification scheme presented in this bulletin was adopted. Types were delineated on the photos after stereoscopic examination and ground checking along roads and trails. The photos were then edited and sent to the Engineering Geomorphics Section of the Forest Service's Pacific Southwest Regional Office, for transfer to base maps and measurement of type areas (tables 1 and 2, figs. 2 and 3).

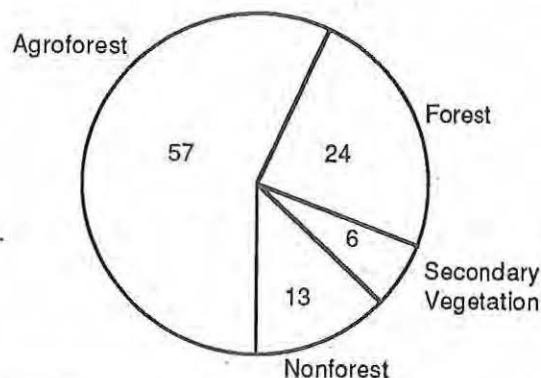


Figure 2—Four major vegetation classes were found on the islands of Moen, Dublon, Fefan, and Eten, Federated States of Micronesia in 1976. These islands have the highest percentage of agroforest in the Federated States of Micronesia.

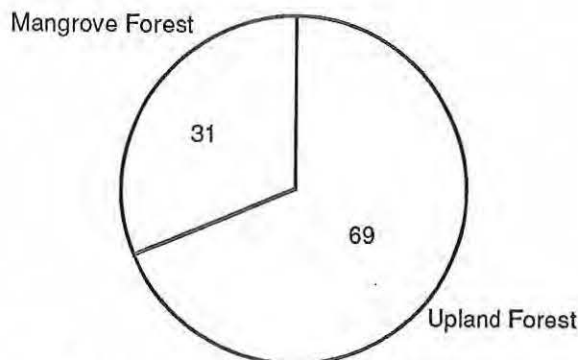


Figure 3—The forest land class, islands of Truk, Federated States of Micronesia, in 1976, consisted of mangrove and upland forests. Of the mapped islands, Moen has the greatest percentage of land in forest vegetation.

TYPE CLASSIFICATIONS

The islands of Truk are divided into four major land classes—forest, secondary vegetation, agroforest, and nonforest. Primary types within the major land classes are given below:

Forest—The forest class includes four types:

- Upland forest (UP)
- Mangrove forest (MN)
- Palm forest (PO)
- Plantation forest (PF)

Secondary vegetation (SV)—Secondary vegetation includes grasses, vines, shrubs, and scrubby trees on recently disturbed areas.

Agroforest (AG)—The agroforest class is made up of areas with trees, under cultivation for food crops, wood, and other products.

Nonforest—Areas without trees or with less than 10 percent trees.

- Marsh (M)
- Grassland or savanna (G)
- Cropland (C)
- Urban (U)
- Barren (B)
- Water (W)

The forest types are further subdivided into size and density classes (table 2) identified by these codes:

Code	Size class
0	Short, shrub-like stands smaller than 12.5 cm (5 in) in diameter at breast height (d.b.h.).
1	Trees averaging less than 30 cm (12 in) in d.b.h. but larger than or equal to 12.5 cm (5 in) in d.b.h.
2	Trees averaging 30 or more cm (>12 in) in d.b.h.

Code	Density class
H	High—crown closure of main canopy over 70 percent.
M	Medium—crown closure of main canopy between 30 and 70 percent.
L	Low—crown closure of main canopy less than 30 percent.

Vegetated areas are numbered and identified by symbols in the legend on the folded maps. In each code, the vegetation type is shown first, followed by the size class and crown density class. For example, MN1H would indicate mangrove between 12 cm (5 in) and 30 cm (12 in) in diameter and a high density crown closure. Where possible, dominant species are identified. In such cases, the density class is followed by a period, then by one or two letters of the genus name, MN1H.N, as when *Nypa fruticans* makes up at least 20 percent of the mangrove stand. Occasionally, two-storied stands are identified by a slash between the overstory and understory classes, with size and density classes given only for the overstory type. For example, UP1M/SV.V would indicate an overstory composed of scattered trees of upland forest species overtopping secondary vegetation having *Hibiscus tiliaceus* as its major component (table 3).

Table 3—Vegetation type codes used for Truk, Federated States of Micronesia

Land class	Vegetation codes	Vegetation types, subtypes and components
Forest	UP	Upland forest, various size and density classes apply
	UP/SV	Secondary vegetation understory
	UP/SV.V	Vine component
	UP.PO	Palm forest component
	UP.AG.CO	Coconut component
	PO	Palm forest, various size and density classes apply
	MN	Mangrove, various size and density classes apply
	MN.N	<i>Nypa</i> palm component
	PF	Plantation forest, various size and density classes apply
Secondary vegetation	SV	Secondary vegetation; size and density classes do not apply
	SV.V	Vine component
	SV.S	Shrub component
Agroforest	AG	Agroforest
	AG/SV	Secondary vegetation understory
	AG/G	Grassland inclusions
	AG.CO	Coconut component
	AG.CO/SV	Coconuts with secondary vegetation understory
	AG.CO/SV.V	Coconuts with vine understory
Nonforest	S	Strand
	M.F	Freshwater marsh
	M.F.C	Freshwater cultivated marsh
	M.F.P	Freshwater <i>Phragmites</i> marsh
	G.G	Grassland, graminoid component
	G.B	Barren component
	G.F	Fern component
	G.S	Shrub component
	C	Cropland
	U	Urban land
	B	Barren
	B.V	Outcrops of volcanic rock
	W	Water, including fresh, saline, and bays

NOTES:

Size and density class codes are used only in the forest class.

All components, inclusions, or understory species must be present on at least 20 percent of the mapped area.

VEGETATION TYPE DESCRIPTIONS

Land classes and primary types are described by habitat and major overstory and understory species listed below. Full citations and families of plants mentioned in the text are given in table 4.

Forest

Upland Forest (UP)

Forests function in protecting watersheds and soil and provide habitat for wildlife. The upland forests of Truk harbor a number of plants and animals found nowhere else in the world and, therefore, are a source of national pride as well.

Table 4—Citations of species found in this bulletin¹

Genus	Species and authors	Family	Genus	Species and authors	Family
Acrostichum	aureum L.	Pteridaceae	Hoya	trukensis Hosok.	Asclepiadaceae
Alpinia	carolinensis Koidz.	Zingiberaceae	Ipomoea	aquatica Forsk.	Convolvulaceae
Areca	cathecu L.	Palmae	Lumnitzera	littorea (Jack) Voigt	Combretaceae
Artocarpus	spp.	Moraceae	Lycopodium	cernuum L.	Lycopodiaceae
Astronidium	carolinense (Kaneh.) Mgf.	Melastomataceae	Macaranga	carolinensis var. carolinensis Volk.	Euphorbiaceae
Balanophora	fungosa Forst.	Balanophoraceae	Macropsychanthus	carolinensis Kaneh. & Hosok.	Fabaceae
Balanophora	indica (Arn.) Griff.	Balanophoraceae	Metroxylon	amicarum Rottb.	Palmae
Bruguiera	gymnorhiza (L.) Lam.F.	Rhizophoraceae	Morinda	citrifolia L.	Rubiaceae
Calophyllum	inophyllum L.	Guttiferae	Nypa	fruticans Wurm.	Palmae
Casuarina	litorea L.	Casuarinaceae	Pandanus	spp.	Pandanaceae
Cleistanthus	morii Kaneh.	Euphorbiaceae	Parinari	laurina Gray	Chrysobalanaceae
Clinostigma	carolinensis (Becc.) Moore & Fosb.	Palmae	Pemphis	acidula Forst.	Lythraceae
Cocos	nucifera L.	Palmae	Pentapthalangium	carolinense Lauterb.	Guttiferae
Cordia	subcordata Lam.	Boraginaceae	Phragmites	karka (Retz.) Trin. ex Steud.	Gramineae
Cynometra	ramiflora L.	Caesalpiniaceae	Piper	ponapense C.D.C.	Piperaceae
Cynometra	yokotai Kaneh.	Caesalpiniaceae	Pisonia	grandis R. Br.	Nyctaginaceae
Cyrtosperma	chamissonis (Schott) Merr.	Araceae	Pouteria	obovata (Br. R.) Baehni	Sapotaceae
Dysoxylum	abo Hosok.	Meliaceae	Premna	obtusifolia R. Br.	Verbenaceae
Embelia	palauensis Mez.	Myrsinaceae	Psychotria	hombroiana var. squarrosa (Val.) Fosb.	Rubiaceae
Eugenia	trukensis Hosok.	Myrtaceae	Randia	carolinensis Val.	Rubiaceae
Ficus	prolixa var. carolinensis (Warb.) Fosb.	Moraceae	Rhizophora	apiculata Bl.	Rhizophoraceae
Flacourtia	rukam var. micronesica Fosb. & Sachet	Flacourtiaceae	Rhizophora	mucronata Lam.	Rhizophoraceae
Garcinia	ponapensis var. trukensis (Kaneh.) Fosb.	Guttiferae	Scaevola	taccada (Gaertn.) Roxb.	Goodeniaceae
Gleichenia	linearis (Burm.f.) C.B.Cl.	Gleicheniaceae	Schefflera	kraemeri Harms	Araliaceae
Glochidion	spp.	Euphorbiaceae	Sonneratia	alba J. E. Sm.	Sonneratiaceae
Guettarda	speciosa L.	Rubiaceae	Swietenia	mahagoni (L.) Jacq.	Meliaceae
Heritiera	littoralis Dry.	Sterculiaceae	Terminalia	catappa L.	Combretaceae
Hernandia	sonora L.	Hernandiaceae	Timonius	ledermanii Val.	Rubiaceae
Hibiscus	tiliaceus L.	Malvaceae	Tournefortia	argentea L.f.	Boraginaceae
			Xylocarpus	granatum Koen.	Meliaceae

¹Scientific names of dicotyledonae follow Fosberg and others (1979), monocotyledonae follow Fosberg (1960), and palmaria follow Moore and Fosberg (1956).

The upland forests mapped in this survey are mostly small relatively inaccessible stands located on mountaintops and rocky ridges. They appear to be concentrations of a number of unique species that developed on a larger land mass. This land mass was reduced when the island sank, leaving only the mountaintops as the lagoon islands of Truk today. With the advent of man, the lower slopes of these islands were converted to agroforest, leaving but remnants of a unique forest flora perched on today's summits.

Plants found in the upland forests of Moen, Dublon, and Fefan include *Clinostigma carolinensis*, *Garcinia ponapensis* var. *trukensis*, *Cynometra yokotai*, *Dysoxylum abo*, *Calophyllum inophyllum* (mainly coastal), *Ficus prolixa* var. *carolinensis*, *Pentapthalangium carolinense*, *Schefflera krameri*, *Flacourtia rukam* var. *micronesica*, *Randia carolinensis*, *Astronidium carolinense*, *Pouteria obovata*, *Eugenia trukensis*, *Parinari laurina*, *Timonius ledermanii*, *Glochidion* spp., *Macropsychanthus carolinensis*, *Cleistanthus morii*, *Alpinia carolinensis*, *Psychotria hombroniana* var. *squarrosa*, *Embelia palauensis*, *Piper ponapense*, *Hoya trukensis*, *Balanophora indica*, and *B. fungosa* (Hosakawa 1937, Okabe 1942).

Mangrove Forest (MN)

The most distinctive vegetation type on the islands mapped is mangrove forest. Mangroves are readily recognized by their dark tone and rounded shapes on aerial photographs. These marine forests have specialized roots that can withstand periodic inundation by seawater.

Mangroves are not as well developed on Truk as on other high Caroline Islands, which is probably due in part to the small land area and, therefore, to the amount of runoff and silt deposits about the islands. Mangroves of Truk have also been damaged by oil spills, especially during World War II, and by landfill operations.

The mangrove type occurs in broken bands along the coasts of the islands surveyed with good examples on the southwest coast of Moen near Wickap and Nukanap Villages. *Rhizophora* spp. and *Bruguiera gymnorhiza* are commonly present, and less often *Sonneratia alba* and *Xylocarpus granatum*. *Heritiera littoralis*, *Nypa fruticans*, and the large fern *Achrostichum aureum* may occur along the landward edge of mangroves.

Mangroves function as a natural filtering and buffering system between the island and lagoon. They also serve as natural fish

nurseries and habitat for birds, and provide posts, firewood, and fishing and gathering grounds for people.

Palm Forest (PO)

Palm forests are areas where palms, other than coconut, *Nypa* or betelnut (*Areca catechu*), make up more than 50 percent of the canopy. The palm forest type is made up of ivory nut palm (*Metroxylon amicarum*), which is native only to Truk and Pohnpei. It is commonly located on the edge of wet areas and occasionally forms pure stands. The endemic palm (*Clinostigma carolinensis*) is a component of upland forest, but is not common in the heavily disturbed forests of the islands surveyed.

Plantation Forest (PF)

Forest plantations are stands planted for commercial forest production, erosion control, or type conversion. The type is limited to a few small plantations of Honduras mahogany (*Swietenia mahagoni*) and other nonnative species planted by the Truk Department of Agriculture and Forestry.

Agroforest (AG)

Agroforest consists of a mixture of food-producing trees and other useful and ornamental species established by the Trukese. The overstory is made up mostly of coconut (*Cocos nucifera*) and breadfruit (*Artocarpus* spp.), coded AG.CO. The canopy is often multistoried and may be interspersed with open areas of taro patches, secondary vegetation, or forest, too small to be demarcated as separate types. The steep hillsides are commonly vegetated by agroforests with a secondary vegetation understory, coded AG.CO/SV (table 3).

Secondary Vegetation (SV)

Areas of small weedy trees, shrubs, vines, and grasses growing in recently disturbed areas are classified as secondary vegetation (SV). This vegetation rapidly invades disturbed areas and protects the soil from erosion by Truk's heavy rainfall. On aerial photos, secondary vegetation is characterized by a low, uneven canopy, generally sparser in appearance than forest types, with a hazy texture. Much of the vegetation of Truk has secondary vegetation as a subcomponent. Including the secondary vegetation land class, fully 25 percent of the islands have a "SV" understory (table 3). Common species include *Hibiscus tiliaceus* and *Macaranga carolinensis*.

Nonforest

Strand Vegetation (S)

This designation is used to distinguish the characteristic collection of species that occupy sandy and rocky coralline coasts of both low and high islands. Species include *Scaevola taccada*, *Tournefortia argentea*, *Pemphis acidula*, *Casuarina litorea*, *Cal-*

ophyllum inophyllum, *Cordia subcordata*, *Hernandia sonora*, *Guettarda speciosa*, *Pandanus* spp., *Pisonia grandis*, *Terminalia catappa*, *Morinda citrifolia*, *Hibiscus tiliaceus*, and *Premna obtusifolia*. Few ocean shores are unaffected by man, and agroforest species such as coconuts and breadfruit are commonly found mixed with this vegetation type. Strand vegetation seldom occurs in areas wide enough to be mapped, but the type is common along the coastline.

Marshes (M)

Areas dominated by grasses, sedges, and herbs growing in standing water most of the year are classified as marshes. Woody vegetation is absent. Graminoid marshes give a characteristic smooth texture on the aerial photos. Two types of marshes are mapped:

- Marsh freshwater (M.F)—Areas generally located slightly above sea level, often landward of mangroves; or in depressions in upland areas. Extensive patches of *Phragmites* marsh occur in the lowlands of Truk and are indicated as M.F.P. Some are at least partially cultivated to taro, mostly *Cyrtosperma chamissonis*, and are typed as M.F.C. Most taro patches are below the minimum size for typing or are mixed with secondary vegetation. The ivory nut palm commonly grows at the edge of marshes. Other species of sedges, and herbaceous growth are common. The edible vine, *Ipomoea aquatica*, is also found growing in marshes.

- Saline Marsh (M.S)—Areas generally along the coast or adjacent to mangroves, or sometimes in depressions, where there are sand or mud flats periodically inundated by saltwater or with standing pools of salt or brackish water. Saline marsh areas are common but generally below the minimum area for demarcation; usually too small to be identified in this survey.

Grassland or Savanna (G)

Grasslands are areas of low herbaceous cover. Shrubs and trees are widely scattered if present. Soils are generally infertile poorly drained clays. Grasslands are probably the result of the destruction of the forest vegetation by fire, which depletes the humus layer and exposes the soil to rain and sun. Subsequent fires prevent tree species from returning.

A number of subtypes of grassland are specified:

- Bare—Areas with very poor soil with patches of bare soil intermittent with low growth (G.B.).

- Fernland—Areas in which the predominant cover is a tangled growth of *Gleichenia linearis* fern, sometimes with a mix of other species including *Lycopodium cernuum*. Once fires are initiated in such areas, they burn the vegetation completely. This process selects against other species and favors *Gleichenia* that regrows from rootstalks (G.F).

- Grasses and sedges—A predominance of graminoid species (G.G).

- Shrubs—Grasslands with a mix of graminoid species and shrubs (G.S).

Cropland (C)

Areas of cultivated lands without tree cover. Most Trukese gardens are below the minimal size to be typed and are included in the agroforest or secondary vegetation classes.

Urban (U)

Towns, villages, and areas developed for nonforest use.

Barren (B)

This designation is applied to areas that lack natural vegetation because of factors such as rocks, sterile soil, and bulldozing.

Water (W)

Includes both fresh and brackish water.

GLOSSARY

Agroforest: An area of mixed growth, including trees cultivated for food, fruit, wood, and other products.

D.b.h.: Diameter at breast height. Tree diameter outside bark measured at breast height, 1.3 m (4.5 ft) above the ground.

Forest land: Land at least 10 percent stocked by live trees or land formerly having such tree cover and not currently developed for nonforest use.

Land area: Land area includes dry land and land temporarily or partially covered by water, such as marshes, swamps, and river flood plains; streams or sloughs.

Land class: A classification of land by major use or major vegetative characteristics—that is—forest, secondary vegetation, agroforest, and nonforest.

Nonforest land: Land that has never supported forests or was formerly forested and is currently developed for nonforest use or degraded.

Secondary vegetation: A vegetation type characterized by small, fast-growing trees, shrubs, grasses, and vines, usually weedy invaders.

Vegetation type: An area delineated on the maps as having similar plant composition to one of the types described in the section on type classification.

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The vegetation of four islands of the State of Truk, Federated States of Micronesia, was mapped for use in land-use planning, forest resource management, and forest surveys. The three vegetation maps cover the islands of Moen, Dublon, Fefan, and Eten. They show the location and extent of vegetation types identified from aerial photographs taken in 1976. Total land area is estimated at 4,170 hectares (10,305 acres) with forest land accounting for 24 percent (986 ha or 2,438 acres). Fifty-seven percent of the land area is planted to agroforest (2,378 ha or 5,877 acres).

Retrieval Terms: vegetation survey, vegetation maps, forest types, Truk, Federated States of Micronesia, Caroline Islands, Micronesia