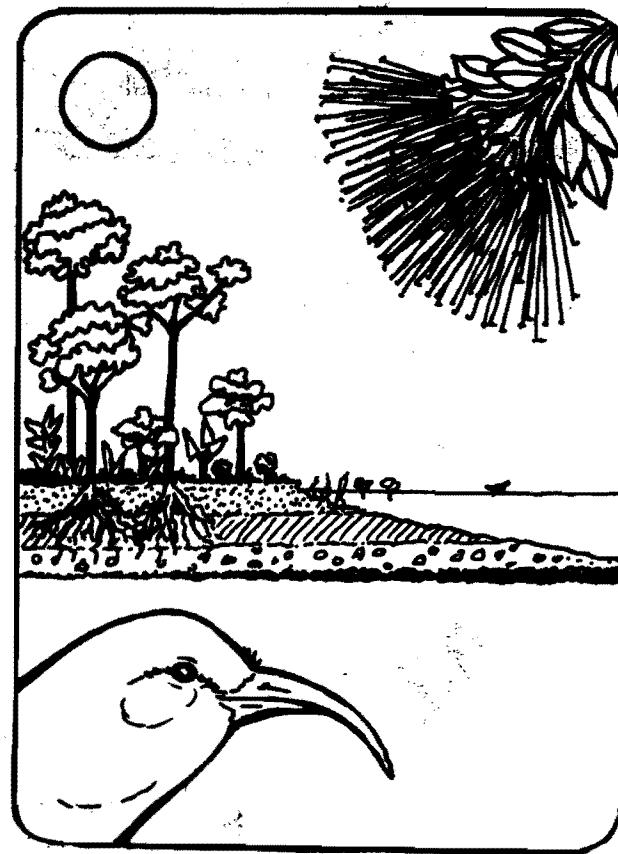


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Honolulu, Hawaii

NATIONAL WETLANDS INVENTORY
for
HAWAII
by
Dennis D. Peters

INTRODUCTION

The U. S. Fish and Wildlife Service, Office of Habitat Resources, is conducting an inventory of the wetlands of the United States. All wetlands are classified according to the Service's new system "Classification of Wetlands and Deepwater Habitats of the United States" (Cowardin, et al. 1979). The National Wetlands Inventory (NWI) is establishing a wetland data base in both map and computer forms for the entire country. The present emphasis is on map production and, in the future, wetland data will be digitized to create an automated wetland data base, as funding becomes available. The NWI information will serve to identify the current status of U. S. wetlands and can be used as a reference point from which future changes in wetlands can be evaluated.

The NWI effort in Hawaii began in early 1983 and was completed in early 1984. Wetlands maps are now available for the islands of Oahu, Maui, Molokai, Kauai, and Hawaii at a 1:24,000 scale (7 1/2' quad sheet) and for Lanai, Niihau, and Kahoolawe at a 1:62,500 scale.

NWI OVERVIEW

The NWI project was initiated in 1974 and an important early effort was to decide how to classify wetlands. It was determined that none of the existing wetland classification systems could be used or modified for this purpose and that a new classification should be created (Wilens, 1981).

The Service's wetlands classification system "Classification of Wetlands and Deepwater Habitats of the United States," (Cowardin, *et al.* 1979) was developed by a team of wetland ecologists with the assistance of local, State, and Federal agencies as well as many private groups and individuals. It went through four major revisions and extensive field testing prior to its publication in December 1979.

Wetlands include the variety of wet habitats commonly called marshes, bogs, and swamps. They are lands where saturation with water or periodic flooding during the growing season determines the nature of soil development and types of plants and animals living there. The Service specifically defines "wetland" as follows:

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin, *et al.* 1979).

Deepwater habitats are permanently flooded lands lying below the deepwater boundary of wetlands and defined as:

...Environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium within which the dominant organisms live...

The classification system is hierarchical with wetlands divided among five major systems at the broadest level: Marine, Estuarine, Riverine, Lacustrine, and Palustrine (figure 1). Each System is further subdivided by subsystems which reflect hydrologic conditions, e.g., subtidal verses intertidal in the Marine and Estuarine System. Below subsystem is the class level which describes the appearance of the wetland in terms of vegetation (e.g., emergent, aquatic bed, forested) or substrate where vegetation is inconspicuous or absent (e.g., unconsolidated shore, rocky shore, streambed). Each class if further subdivided into subclasses. The classification also includes modifiers to describe hydrology (water regime), water chemistry (pH, salinity and halinity) and special modifiers relating to man's activities (e.g., impounded, partly drained, farmed, artificial).

Due to the magnitude of a national inventory, the NWI uses high-altitude aerial photography as the primary data source. When taking into consideration the combined cost of air photo acquisition, plotting work areas on the photos, photointerpretation and transferring the annotated information to overlays/maps, the decision on what scale of photographs is adequate to do the job is critical (Wilen, 1981). The preferred aerial photography is 1:60,000 scale color infrared available through the National High Altitude Photography Program (NHAP).

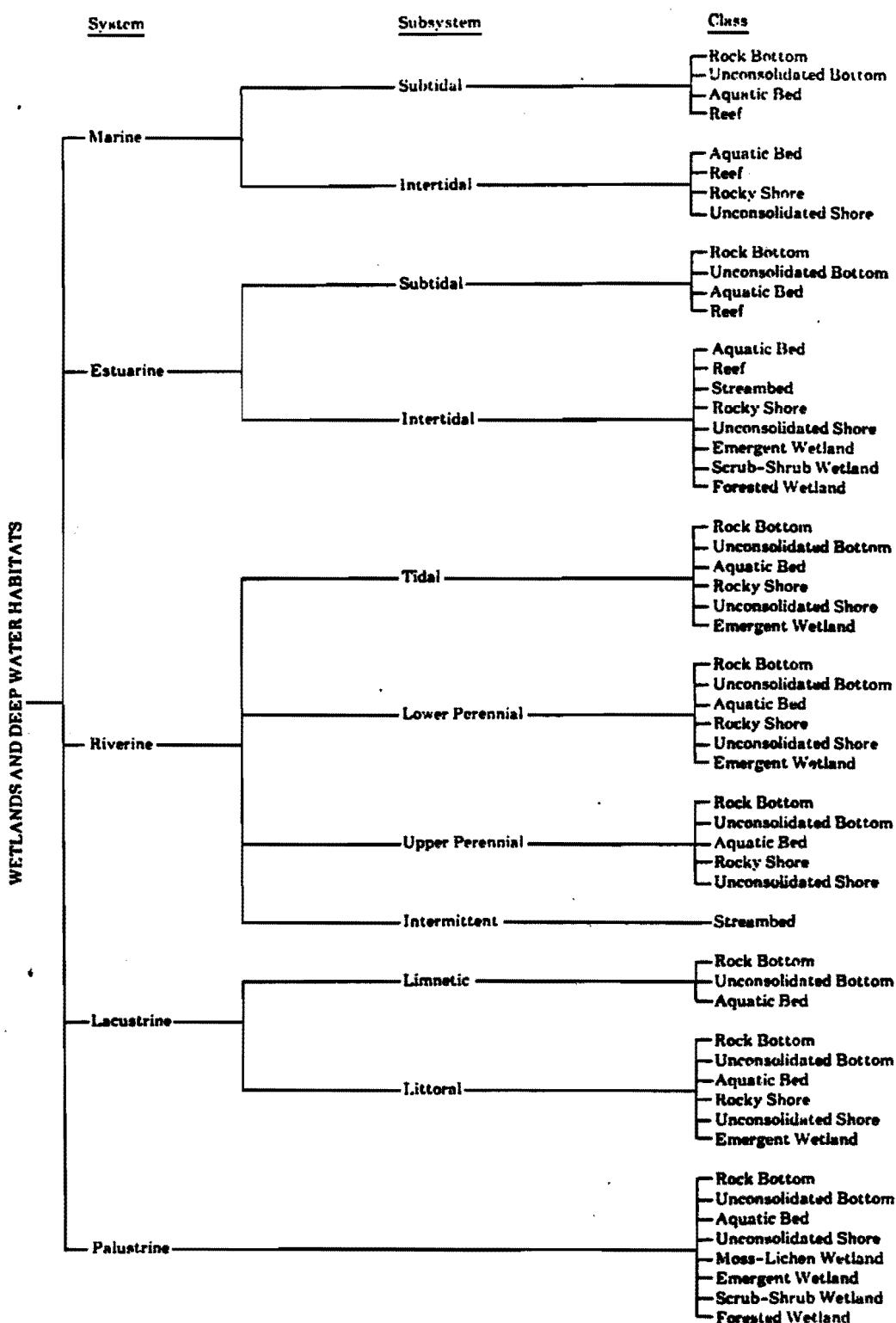


Fig. 1. Classification hierarchy of wetlands and deepwater habitats, showing systems, subsystems, and classes. The Palustrine System does not include deepwater habitats.

The aerial photography is stereoscopically reviewed and, using standard aerial photointerpretation procedures, wetland/deepwater habitat boundaries and classifications are delineated on the photos. The wetland data on the aerial photographs is transferred to the largest scale USGS base map available for the area. The map scale most often used is 1:24,000, but 1:62,500 scale maps are also used.

To date, NWI mapping is on-going or completed for over 30% of the mainland, 5% of Alaska, the island of Guam, in addition to seven of the Hawaiian Islands (NWI, 1984)

HAWAII

The NWI for Hawaii followed standard NWI procedures-- acquisition of existing aerial photography and collateral data, initial air photointerpretation, field checking, quality control of interpreted photos, production and distribution of draft products, interagency review and NWI revision of draft products, and production of NWI wetland maps.

Aerial Photography

Most of the aerial photography used was 1:48,000 scale black and white taken in February and December 1977 and January 1978. The overall quality, resolution, and contrast of the photography was good. A limited number of photos had scattered cloud cover but did not significantly interfere with photointerpretation.

Primary collateral data included Corps of Engineers true-color aerial photography of the coastal areas, Soil Conservation

Service Soil Surveys (USDA 1972 & 1973), an existing wetland survey (Elliott and Hall, 1977), and wetland plant guide (Stemmermann, 1981).

Air Photointerpretation

Aerial photointerpretation of wetlands/deepwater habitats are in accordance with NWI established mapping procedures (NWI, 1982). Wetlands/deepwater habitats were identified on the aerial photographs based on vegetation, visible hydrology, and geography using the Service's wetland definition and classification system.

Field reconnaissance was conducted March 11-22, 1983, covering areas on Oahu, Maui, Kauai, and Hawaii. Field sites were based on initial review of the aerial photography and potential photo interpretation problems. At each field check site, the preliminary interpretation and aerial photo signature were related to the vegetation, soil type, hydrology, and topography. A determination of wetland or non-wetland was made, the wetland-upland boundary determined, and the wetland classified. These site specific data were used in completing and revising the wetland delineations.

Wetland photo interpretation, although efficient and accurate for inventorying wetlands, does have certain limitations. The most significant problem with the photointerpretation of the Hawaiian Islands was using black and white photography. This created a problem with detail and System delineations where vegetation types and coral reefs were not clearly discernible. This required careful use of the topographic maps, soil surveys, and input from individuals

familiar with Hawaiian wetlands/deepwater habitats. In addition, the scale of the photography precluded identification of some of the smaller wetlands.

Map Products

The NWI has produced 122 1:24,000 scale wetland maps for Hawaii: 11 for Kauai, 15 for Oahu, 5 for Molokai, 17 for Maui, and 74 for Hawaii. There are three 1:62,500 scale maps: One each for Lanai, Kahoolawe, and Niihau (figures 2 and 3). These large-scale maps are composite maps which show the location, shape, and classification of the wetlands/deepwater habitats on USGS base maps.

Initial NWI draft review products were photo enlargements of the aerial photography, with wetland/deepwater habitat delineations and classifications, to an approximate scale of 1:24,000. These photo enlargements were provided to personnel from the U. S. Fish and Wildlife Service, Soil Conservation Service, Corps of Engineers, State Department of Land and Natural Resources, University of Hawaii Department of Botany, and the Nature Conservancy of Hawaii for review, use, and comments. Review comments were received from each of the agencies except the Nature Conservancy.

Following receipt and evaluation of the review comments, the accuracy and completeness of the photointerpretation was reevaluated and necessary changes, additions, and/or delineations made on the aerial photos. The delineations on the aerial

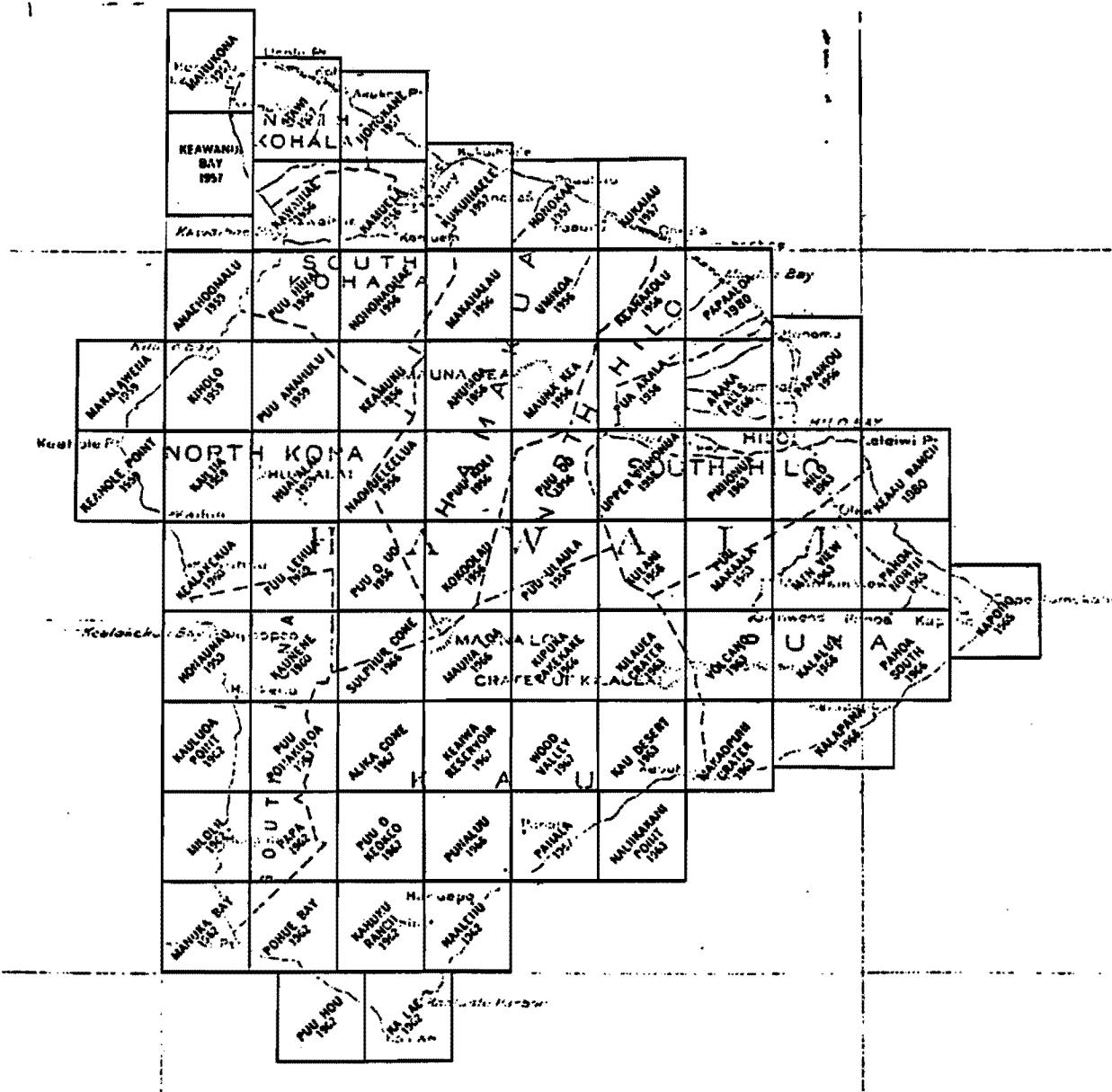


FIGURE 2: Index of NWI wetland maps for Hawaii (from USGS topo. maps of Hawaii, American Samoa, and Guam, April 1981).

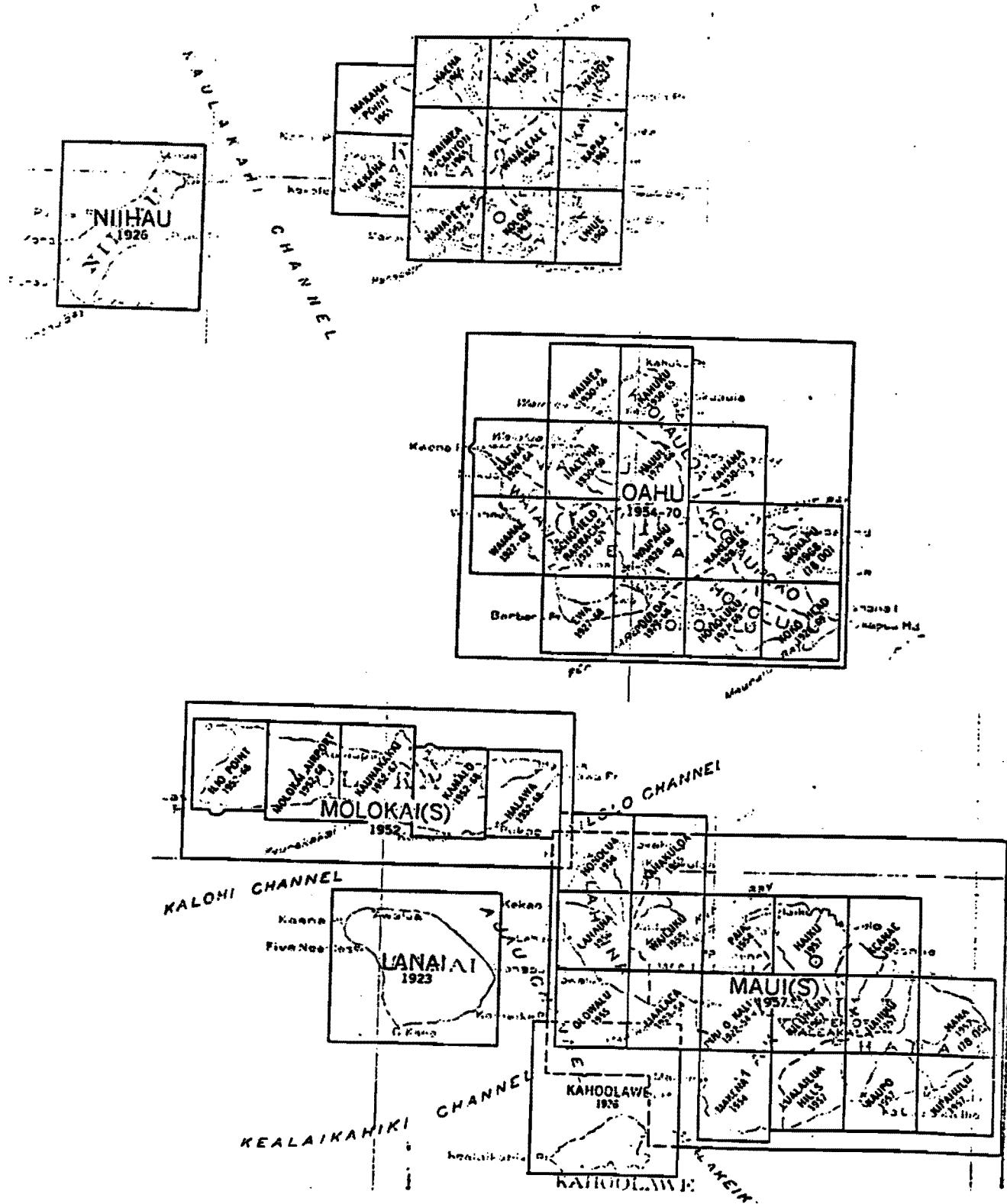
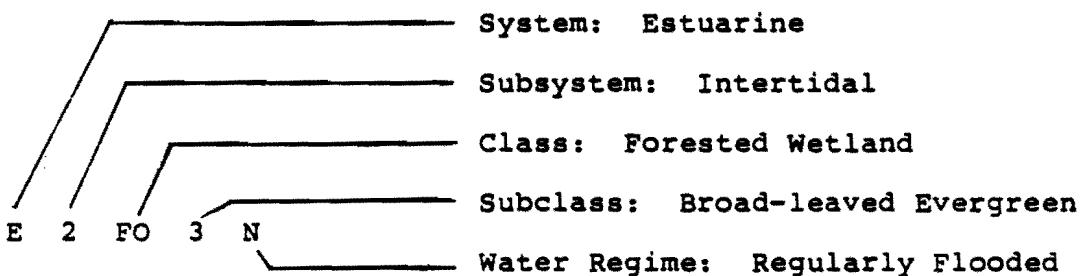


FIGURE 3: Index of NWI wetland maps for Kauai, Oahu, Molokai, Maui, Lanai, Kahoolawe, and Niihau (from USGS index to topo. maps of Hawaii, American Samoa, and Guam, April 1981).

photography were transferred to the USGS base maps using a zoom transfer scope to eliminate most distortions associated with aerial photography.

Wetland/deepwater habitat classifications are displayed on the NWI wetland maps by a series of letters and numbers (alpha-numerics) corresponding to the elements of the Service's wetland classification system. The first letter represents the System and subsequent alpha-numerics represent, in a sequential manner, subordinate levels of detail. The following is a typical alpha-numeric illustrating a wetland classification to water regime level of detail.



All map legends also include the following special note:

SPECIAL NOTE

This document was prepared by stereoscopic analysis of high altitude aerial photographs. Wetlands were identified on the photographs based on vegetation, visible hydrology, and geography in accordance with "Classification of Wetlands and Deep-Water Habitats of the United States", Cowardin, et al, 1977. The aerial photographs typically reflect conditions during the specific year and season when they were taken. In addition, there is a margin of error inherent in the use of the aerial photographs. Thus, a detailed on the ground and historical analysis of a single site may result in a revision of the wetland boundaries established through photographic interpretation. In addition, some small wetlands and those obscured by dense forest cover may not be included on this document.

Federal, State, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, State, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, State, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Wetland Communities

This discussion is a general overview of wetlands/deepwater habitats in Hawaii as mapped by the NWI. It is not a complete list of NWI mapping codes and examples nor does it contain a complete vegetation list, but rather reflects general wetland plant communities observed during the field work.

All five Systems of the Service's wetland classification system--Marine, Estuarine, Riverine, Lacustrine, and Palustrine--occur in Hawaii.

Marine

Commonly occurring wetlands/deepwater habitats in the Marine System include the classes coral reef, rocky shore, and unconsolidated shore. Coral reefs were not always evident on the aerial photography and, in some areas, it was necessary to use collateral data (USGS quad sheets and/or coastal surveys) to map the coral reefs. The coral reefs are classified Marine (M), subtidal (l), reef (RF), coral (l), subtidal water regime (L). Rocky shore and unconsolidated shore classes were clearly visible

on the photography and classified as Marine, intertidal, rocky shore, bedrock, regularly flooded water regime (M2RS1N) or unconsolidated shore, sand (M2US2N). These shoreline wetlands, for the most part, are mapped as linear features and the distinctions between the various water regime modifiers were either not evident on the aerial photography or too small to map. Figure 4 (a portion of the Kaneohe map) illustrates NWI mapping in the Marine System.

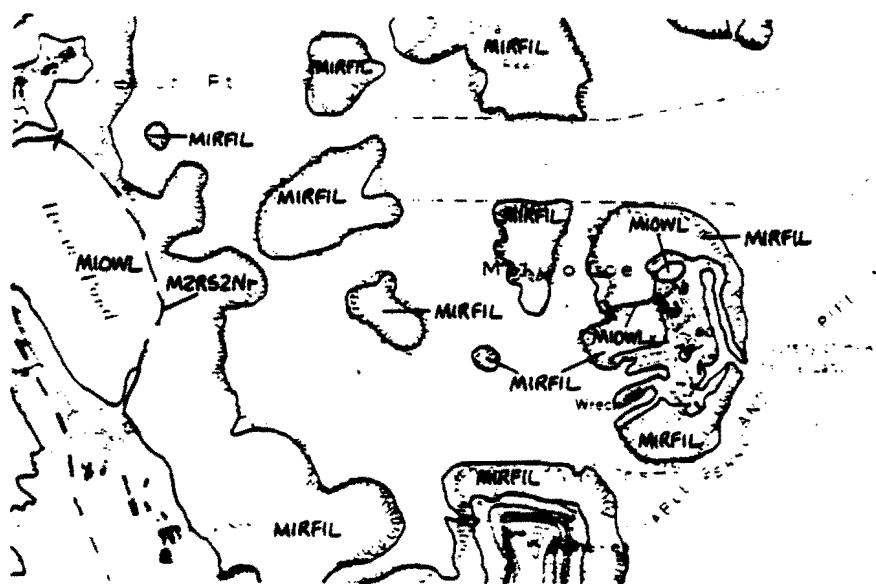


Fig. 4. Portion of Kaneohe NWI wetland map.

Estuarine

The major wetlands and deepwater habitats in the Estuarine System include the classes open water (OW), forested (FO), scrub/shrub (SS), and emergent (EM).

The open water/unknown bottom class is characterized by water on the aerial photography and is classified Estuarine, subtidal, open water with a subtidal water regime modifier (E2OWL).

The Estuarine forested and scrub/shrub wetlands are within the intertidal subsystem and characterized by mangroves. The sites field checked were dominated by red mangrove (Rhizophora mangle) and the less common oriental mangrove (Bruguiera gymnorhiza). Depending on height (greater or less than 6m), these areas are classified Estuarine, intertidal, forested, or scrub/shrub, broad-leaved evergreen (E2FO3 or E2SS3) with a regularly flooded (N) or irregularly flooded (P) water regime modifier depending on tidal range and seaward limit of the mangroves. An example is shown for a portion of the Kaunakakai map (figure 5).

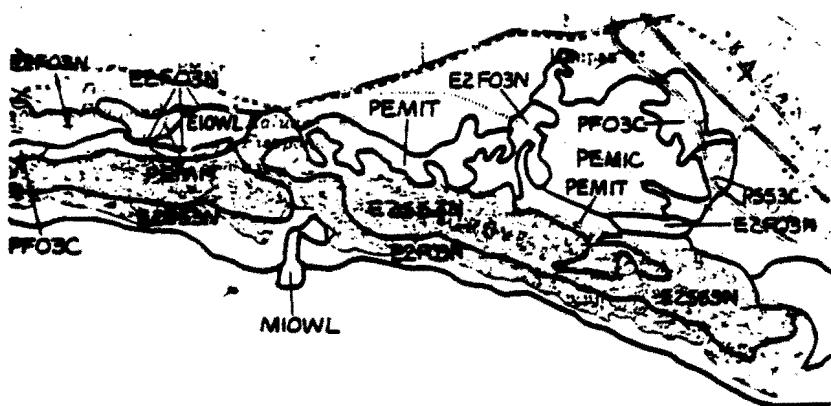


Fig. 5. Portion of Kaunakakai NWI wetland map.

The Estuarine, intertidal, emergent wetlands are relatively small with limited tidal influence. The vegetation is persistent commonly consisting of pickleweed (Batis moritima), sea purslane (Sesuvium portulacastrum), Indian pluchea (Pluchea indica), and salt grass (Sporobolus virginicus). The water regime modifiers are either regularly or irregularly flooded. Thus the NWI codes E2EM1N or P.

Riverine

Riverine wetlands/deepwater habitats are present throughout the seven Hawaiian Islands. However, many were not mapped because they are obscured on the aerial photography by a tree canopy which is classified in the Palustrine System.

The permanent rivers include both upper and lower perennial subsystems of the Riverine System with the predominate class open water. The lower perennials (R2OWH) are found in the coastal plains with the upper perennials (R3OWH) found in the higher elevations, both with a permanently flooded water regime modifier.

There are many dry streambeds generally found on the leeward side of the islands. These streams do not flow year around and are classified as Riverine intermittent streambed (R4SB) with a temporarily (A), seasonally (C), or intermittently (J) flooded water regime.

Figure 6, from the Hauula map, shows two Riverine classifications and a Palustrine forested wetlands which obscures a streambed.



Fig. 6. Portion of Hauula NWI wetland map.

Lacustrine

Natural or artificial basins greater than 20 acres are in the Lacustrine System; these wetlands/deepwater habitats are not overly common on the Hawaiian Islands. As classified and mapped on the NWI maps, the Lacustrine System generally includes the class open water with the special modifier impounded--Lacustrine (L), limnetic (l), open water (OW), permanently flooded (H), impounded special modifier (h). Figure 7 (portion of Kapaa map) illustrates this mapping.



Fig. 7. Portion of Kapaa NWI wetland map.

The island of Niihau has several large areas classed as Lacustrine, littoral, unconsolidated shore, mud, seasonally or temporarily flooded water regime, and mixosaline water chemistry modifier (L2US3C or A9). Since these areas were not field checked, the classification is based on various review comments (Ford, 1983; Sincock, 1983).

Palustrine

The majority of the wetlands/deepwater habitats mapped by the NWI are within the Palustrine System. These habitats consist

primarily of those dominated by woody vegetation (forested or scrub/shrub), by herbaceous vegetation (emergent wetland) or by open water.

The Palustrine, open water/unknown bottom classification, for the most part, describes farm ponds or small impoundments. The water regime modifiers may be permanently flooded, intermittently exposed, or semi-permanently flooded and generally with an excavated (x) or a diked/impounded (h) special modifier (figure 8 from the Puu Oo map).

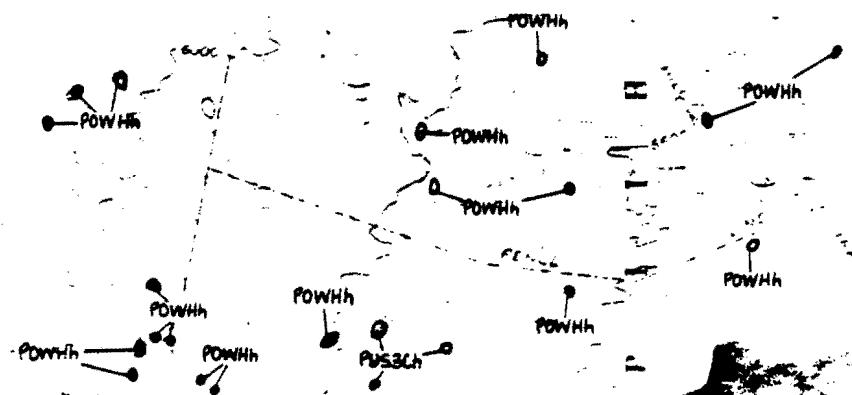


Fig. 8. Portion of Puu Oo NWI wetland map.

Palustrine emergent wetlands, are characterized by persistent vegetation and by a wide range of water regime modifiers from temporarily to semipermanently flooded (PEM1A, B, C or F). These wetlands are characterized by various plant species; the most common species noted during the NWI field checks was California grass (Brachiaria mutica). Other species include, but are not limited to, bulrush (Scripus spp), spreading dayflower (Commelina diffusa), barnyard grass (Echinochloa

crusgalli), sedge (Cyperus spp), torpedo grass (Panicum repens), native sawgrass (Cladium leptostachyum) and shrubby water primrose (Ludwigia octovalvis). Figure 9 illustrates NWI mapping for the Kawainui Marsh on Oahu.

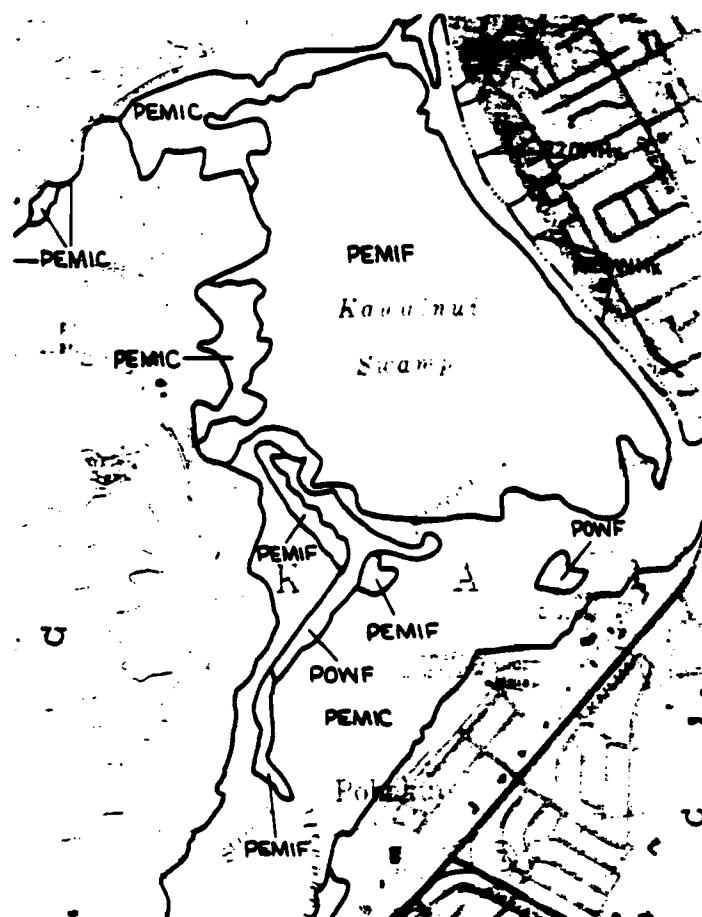


Fig. 9. Portion of Oahu NWI wetland map.

Taro fields are classified on the NWI maps as Palustrine emergent wetlands, persistent, with a mixed artificially/semipermanently flooded (KF) water regime modifier and a diked/impounded (h) special modifier. Thus the NWI code PEMIKFh.

Palustrine wetlands characterized by woody vegetation are classified as either forested or scrub/shrub (depending on height) and all are broad-leaved evergreen at the subclass level (PFO3) or PSS3). These wetlands are found in the coast plains, along river flood plains or as linear bands along rivers. Water regime modifiers range from intermittently flooded to seasonally flooded. A common species is Hau (Hibiscus tiliaceus); associated species include java plum (Eugenia cumini), brazilian pepper (Schinus terebinthifolius) and guava (Psidium guajava). As shown on figure 10 from the Hanalei map, these forested wetlands are often in association with emergent wetlands.

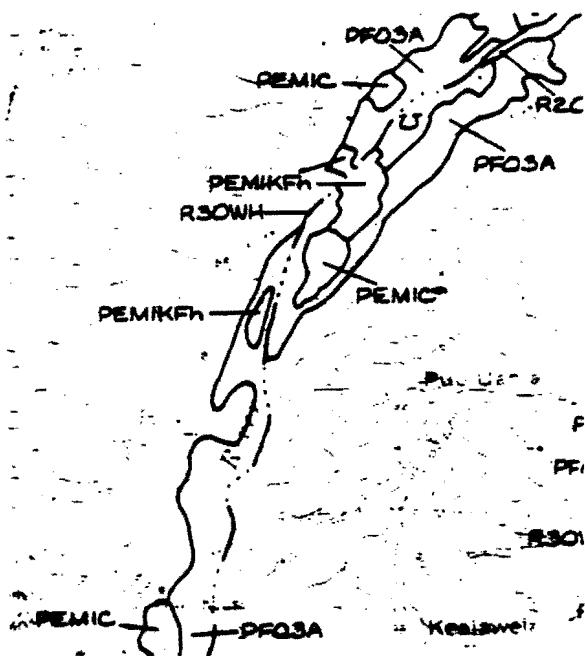


Fig. 10. Portion of Hanalei NWI wetland map.

Large areas of forested wetlands occur in the higher elevation on Kauai, Hawaii, Maui, and Molokai. However, field checking to determine the classification and boundaries of these forested wetlands were done only on Kauai and Hawaii. The predominate water regime modifier applied to these forested wetlands were semipermanently flooded or saturated (PFO3F or B). Interspersed throughout these forested wetlands are saturated emergent wetlands (PEM1B) (figure 11, Haena map). Some noted species include ohia (Metrosideros collina polymorpha), olapalapa (Cheirodendron trigynum), blue berry (Vaccinium calycinum), false staghorn (Dicranopteris spp.) sedges (Carex spp., Cyperus spp.), painiu (Astelia spp.) and beakrush (Rhynchospora lavarum).

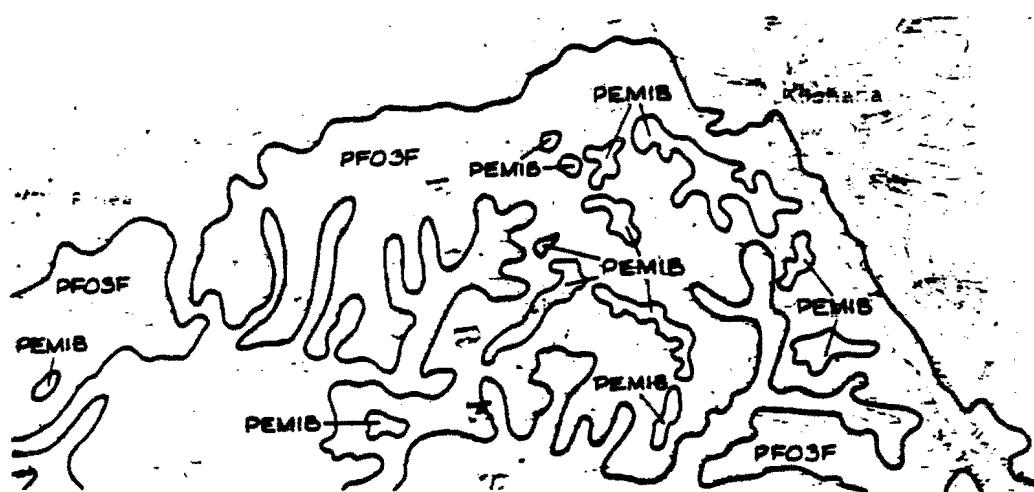


Fig. 11. Portion of Haena NWI wetland map.

Several forested and scrub/shrub wetlands were classified as a wetland/upland mix (PFO/u). These are areas of upland forested plant communities with forested or scrub/shrub wetlands, saturated water regime, scattered throughout. The subtle breaks

were undetectable on the aerial photography, thus the mixed wetland/upland classification on the NWI wetland maps. These wetland/upland areas generally follow the reconnaissance level soil survey delineations and were the result of input during review of draft products (Jacobi, 1983).

DISTRIBUTION OF PRODUCTS

The NWI has a limited reproduction and dissemination capability that has been implemented in order to make maps and overlays available to potential users. Copies of wetland maps are being distributed by the Fish and Wildlife Service Regional Office to the Service's Honolulu field Office, SCS, Corps of Engineers, State Department of Lands and Natural Resources, University of Hawaii, and appropriate county planning departments.

The NWI cannot continue this system of national dissemination because of the burden it has placed on the Regional Offices and the financial burden it has put on the National Wetlands Inventory project. Accordingly, the NWI has established an agreement with the U. S. Geological Survey to have distribution of additional wetland maps handled through the National Cartographic and Information Center (NCIC) in Menlo Park, California.

Requests for NWI wetland maps and/or information should be directed to:

Regional Wetland Coordinator U. S. Fish and Wildlife Service Lloyd 500 Building 500 NE Multnomah Street Portland, Oregon 97232 (503) 231-6154	Chief NCIC U. S. Geological Survey 345 Middlefield Road, M. S. 32 Menlo Park, California 94025
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