The Hawaiian Archipelago: Isolated, Ancient, Continually Renewed

What we know today as the Hawaiian Archipelago actually consists of three distinct landforms all created by the same volcanic "hot spot"; an apparently stationary feature in the middle of the Pacific tectonic plate (See Figure 3). This hot spot pushes lava upwards from deep with in the earth's crust and over time forms a mountain which eventually reaches the surface of the ocean, and continues to grow. Meanwhile, the Pacific plate slowly moves in a northwest direction away from the hot spot carrying the landmass with it. In conjunction with this lateral movement, the sea floor actually sinks as it moves away from the hot spot. The combination of this sinking tendency and the powerful forces of erosion by wind, rain and sea begin to wear the young island down. Thus, the youngest islands are those at the southeast portion of the island chain, and the islands get progressively older as one travels west.



Figure 1. Hawaii is the most isolated archipelago in the world. Image courtesy of Google Earth.

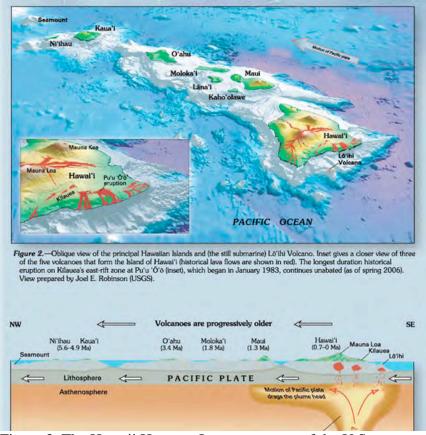


Figure 3. The Hawaii Hotspot. Image courtesy of the U.S. Geological Survey.

The process of creating new land from lava continues to this day. Kilauea volcano in Hawaii Volcanoes National Park has been continually erupting since 1983. Visitors to Kilauea are treated to a rare spectacle of molten lava pouring into the ocean. Kilauea lies on the eastern flank of another volcano, Mauna Loa, which rises to over 13.000 ft above sea level. When measured from the sea floor to the summit, Mauna Loa is the tallest mountain on the planet.

The High Islands

Those islands that have not been eroded down to sea

level are known as "high islands". The Main Hawaiian Islands which sustain permanent populations are all high islands. In the millions of years that it takes for an island to move away from the hot spot, significant changes take place in soil chemistry and structure as the lava weathers and ages. Thus, soil fertility and the landscape itself are very different from island to island.

The "Big Island" of Hawaii is the youngest island in the archipelago. Mauna Loa, or "Long Mountain" on the Island of Hawaii is the highest island in the state and rises gently from



Figure 2. Hawaii's tallest mountain is Mauna Loa is often covered in snow from November to February.

sea level to 13,680 ft. The island of Hawaii has rich, young volcanic soils, and many portions of the island are still so porous that they do not support perennial streams.

At the western end of the high islands lies Kauai; the oldest of these high islands. Kauai has highly weathered and compacted soils, it supports many perennial streams and its highest peak is only 5,148 ft.

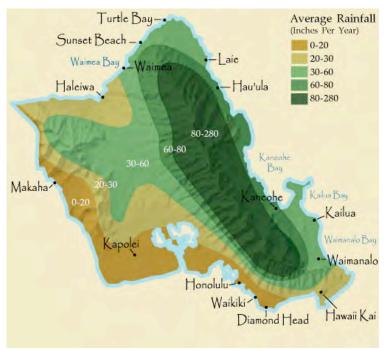


Figure 4. Average Rainfall on the Island of Oahu clearly shows wet "windward" side and dry "leeward" side found on all of the islands. Image courtesy of Chris Spears.

High islands also produce a precious commodity; water. As the tradewinds approach a high tropical island, the air that has traveled thousands of miles over the open ocean rises and drops its cargo of rain. Trees on the forested peaks also capture fog from the misty clouds. This rainfall and fog drip are essential in sustaining life on the high islands. The wet northeastern portion of all of Hawaii's high islands, known as the "windward side," are wet and support rainforests and cloudforests.

As the winds cross the ridges, they have lost most of their moisture, and so little rain falls. The dry southwest portion of each island is known as "On the Island, we do it Island Style, From the mountain to the ocean from the windward to the leeward side."

Lyrics to a popular Hawaiian song by John Cruz.

the "leeward side", or in Hawaiian, the *kona* side of the island. The forests of the *kona* side of the islands are very different from those found on the windward side. These dry forests grow more slowly and are more prone to wildfire. This difference is clearly shown in Figure 4.

For this reason, Ralph Hosmer, Hawaii's first forester identified two types of forest in Hawaii: "protection forests",

defined as those on the wet windward slopes from which the most important product of which was water; and, "commercial forests", defined as those from which the most important product was wood.

Throughout the world, the tropical dry forests are the most endangered and Hawaii is no exception. The Puuwaawaa unit of the Hawaii Experimental Tropical Forest is highly degraded, and it is our hope that research and adaptive management of this area will provide insight into managing dry tropical forests throughout the world.

The Atolls of the Northwestern Hawaiian Islands



Map of the USA with the Hawaiian Archipelago overlaid. Black outline shows the boundary of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, which is 1200 Nautical Miles long by 100 Nautical Miles wide and has an area roughly the same size as Florida and Georgia combined, or 131,800 square statute miles.

Figure 5. The U.S. Mainland with the State of Hawaii overlaid.

Once a high island has eroded to sea level, all that remains is the live coral reef that once ringed the high islands. Corals require sunlight for their survival, and grow at the rate of approximately 1 cm per year. As the Pacific plate continues its movement to the northwest, and as long as the corals can keep up with the sinking of the plate, a coral atoll forms. The State of Hawaii includes these coral atolls, which are referred to as the Northwestern Hawaiian Islands. These atolls are not capable of sustaining permanent human populations because they do not have the ability to capture rainwater as the Main Hawaiian Islands do. Nevertheless, they are rich in marine life, and support huge populations of sea birds. They are also the habitat of the Hawaiian Monk Seal, one of the most endangered animals in the world.

For these reasons, the Northwestern Hawaiian Islands were designated as the Papahanaumokuakea Marine National Monument. The Papahanaumokuakea Marine National Monument is the single largest conservation area under the U.S. flag, and one of the largest marine conservation areas in the world. It encompasses 139,797 square miles of the Pacific Ocean (105,564 square nautical miles) - an area larger than all the country's national parks combined. (See Figure 5.)

The First Hawaiians and The Ahupuaa System

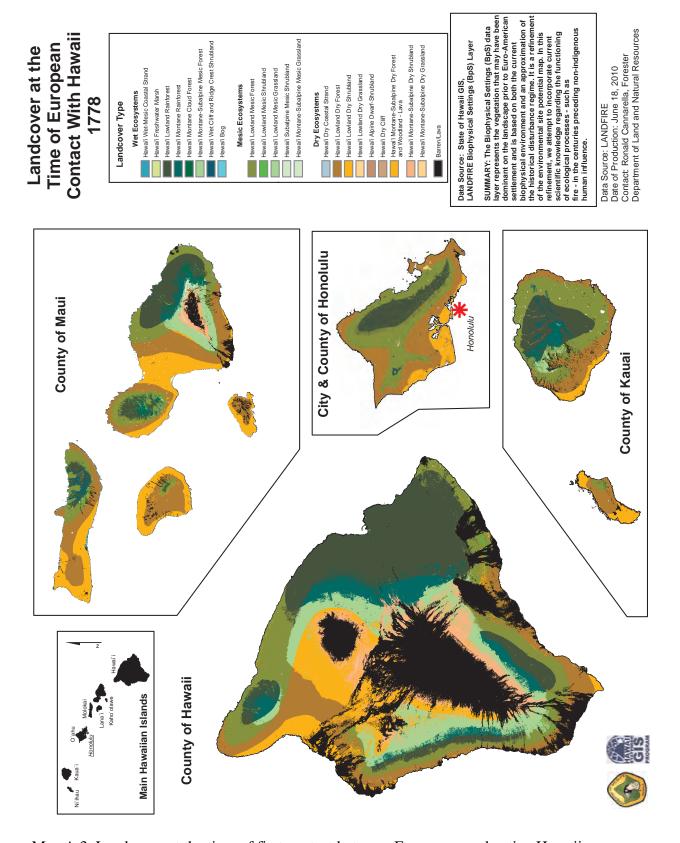
Hawaii is renowned as a tropical paradise, and anyone fortunate enough to visit or reside in these fair islands can attest to the beauty of our forests, beaches, waterfalls and coral reefs. This is no accident; it is the result of centuries of land stewardship practices and cultural values that have perpetuated the land and sustained its people. Our values are rooted in the close bond between the first people to populate these islands, the native Hawaiians. They developed a unique land stewardship system, called the *ahupuaa* system. In the *ahupuaa* system the land was managed a series of nested units. The most fundamental of these was the *ahupuaa*, which generally followed

geographical watershed boundaries (Figure 6). The *ahupuaa* was managed as a single unit, from the mountain tops, in Hawaiian these areas are the *wao akua*, or realm of the gods, to the *wao kanaka*, or realm where people lived and tended their agricultural lands, and out to the reef.

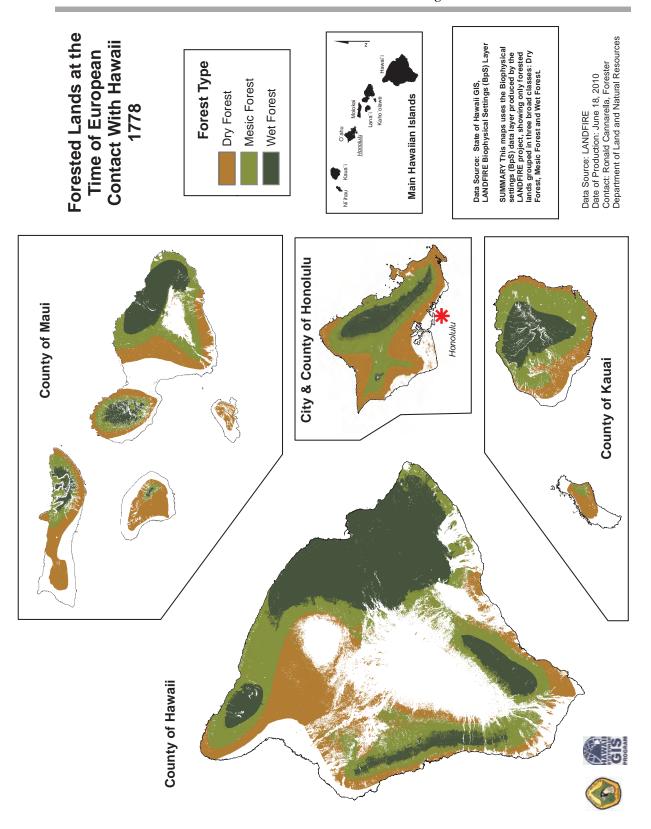
In 1778 the legendary explorer Captain James Cook happened upon the Hawaiian archipelago on



Figure 6. Organization of a Traditional Hawaiian ahupuaa.



Map A.3. Landcover at the time of first contact between Europeans and native Hawaiians.



Map A.4. Showing only the forested lands at the time of first contact between Europeans and native Hawaiians.

his third voyager of discovery. In Hawaii he encountered a large and thriving population and a healthy functioning ecosystem. See Map A.3 for a map of landcover at the time of European Contact and Map A.4 depicting only the forested lands at that time.

In the years that followed, change came swiftly to Hawaii as a result of introduced ideas, new technologies such as metal tools and firearms, introduced animals, and diseases to which the native Hawaiians had never been exposed. Honolulu with its deep water port, abundant natural resources and friendly people soon became a favorite way station for whalers and traders crossing the Pacific Ocean.

The Hawaiians adapted to these changes beyond their control in remarkable ways. Within 15 years of Captain Cook's first contact in 1778, King Kamehameha I transformed Hawaii from a number of warring island-states to a modern nation and eventually a constitutional monarchy.

Soon thereafter, Christian missionaries, whalers and entrepreneurs, mostly from the United States brought new ideas of religion and land tenure. Within two generations, in 1831 Queen Kaahumanu officially outlawed the official state religion, known as the *kapu* system and replaced it with Christianity as the new state religion. In a similar vein, the *ahupuaa* system was

"We are in trouble because we have no firewood and no la'i [ti leaf], and no timber for houses, it is said in the law that those who are living on the land can secure the things above stated, this is all right for those living on the lands which have forests, but, we who live on lands which have no forests, we are in trouble. The children are eating raw potato because of no firewood, the mouths of the children are swollen from having eaten raw taro. We have been in trouble for three months, the Konohikis with wooded lands here in Kaneohe have absolutely withheld the firewood and la'i and the timber for houses." (Letter from Hio et al. to House of Representatives, 1851) Source: 2004 Paul F. Nahoa Lucas, "No Ke Ola Pono o Ka Lahui Hawaii" Hulili: Multidisciplinary Research on Hawaiian Well-being, Kamehameha Schools.

officially abolished by the stroke of the pen in 1848 when King Kamehameha III (Kauikeaouli) instituted a new land tenure system similar to that of the United States in a process known as the Great Mahele. The Great Mahele divided all lands into one of three classes; privately owned fee simple, lands reserved for the government and lands reserved for the Crown.

The consequences of the Great Mahele were profound and yielded some unanticipated results. Instead of providing the native Hawaiians with the security of owning their own lands, many native Hawaiians were instead disenfranchised from their lands. Large agricultural interests, mostly owned by American entrepreneurs, acquired large tracts of land, and the era of large-scale plantation agriculture began based mostly on sugar cane. Private land was consolidated in the hands of a few large landowners, and laborers were imported from China, Japan, the Philippines, Korea, Puerto Rico and Portugal to work the fields.

While a few large landowners grew wealthy, the condition of the forests of Hawaii continued to

deteriorate due to the ever-increasing number of feral animals pushing further into pristine ecosystems. Native Hawaiians suffered as well. Shortly after contact with Europeans, the native Hawaiian people, who had been self-sufficient for centuries, increasingly experienced homelessness, hunger, and disease. Thousands of native Hawaiians perished in mass epidemics as waves of new introduced diseases swept over the islands. Soon immigrants and non-Hawaiian locally born residents outnumbered the native Hawaiians. By the end of the 1800's the economy of the Kingdom was faltering, and the large colonial powers of the era, England, Spain, France and the United States all had their sights on Hawaii and its most coveted asset: the deepwater port of Pearl Harbor.

In 1893, a small group of American sugar planters unilaterally declared an end to the monarchy, proclaimed themselves the new Provisional Government of the Hawaiian Islands and immediately sought the support of an American war ship anchored in Honolulu harbor. In that moment the Kingdom of Hawaii was abolished and Queen Liliuokalani, last reigning monarch of the Kingdom of Hawaii was imprisoned in the Royal Palace. The Queen realized that the native Hawaiian and remaining loyal Hawaiian subjects would be no match for the new American superpower, and so she called upon her people not to take up arms or shed blood trying to resist the new government, but instead to focus on protecting their families, preserve their culture, and survive as a people.

In 1900, the United States officially annexed the Hawaiian Islands as the Territory of Hawaii. All government lands and crown lands from the Great Mahele, collectively referred to as the Ceded Lands, were transferred to the United States, which then entrusted the Territory with the stewardship of those lands. The status of the Ceded Lands is still being debated in the courts, in the Hawaii Legislature and in Congress. Ironically, the native Hawaiian people are still not officially recognized by the Federal Government. This stands in stark contrast to the official relationship that the Federal Government has with all remaining Native American tribes in the other 49 states. This issue is still unresolved, but like so many other challenges that native Hawaiians have faced, this issue too will one day be resolved.

One of the top priorities of the Territorial government, however, was to address the serious environmental problems that was affecting every citizen of these islands at the time. First and foremost was the crisis caused by deforestation and the resulting water shortages.

The Water Crisis of 1875 and Hawaii's First Statewide Assessment and Resource Strategy: 1902

Prior to 1820 all of Honolulu's domestic drinking water was obtained from natural springs and the small river that runs through Nuuanu Valley. The requirements of supplying whaling ships caused a waterfront storage tank to be installed at the lower end of Nuuanu Street. The water for that tank came from a taro patch on Emma Street. The demand for drinking water from various springs and the Nuuanu River spurred the development of a public water supply distribution system that, upon its completion in 1862 provided water to the residents and businesses in

downtown Honolulu. The American writer Mark Twain was pleasantly surprised at how sophisticated Honolulu was when he first visited the islands in 1866. In his first essay written after arriving from San Francisco he describes his first impressions of Honolulu; his hotel room, exotic trees like mango and tamarind, and the price of doing laundry. He specifically comments on the public water supply.

"The water is pure, sweet, cool, clear as crystal, and comes from a spring in the mountains, and is distributed all over the town through leaden pipes. You can find a hydrant spurting away at the bases of three or four trees in a single yard sometimes, so plenty and cheap is this excellent water. Only twenty-four dollars a year supplies a whole household with a limitless quantity of it"³

Even as he wrote these words, native Hawaiians and long-term residents were expressing concern about two disturbing trends that seemed to somehow be linked; the destruction of upland forests by feral cattle, goats, boar and sheep, and the observation of the drying up of springs and rivers. The rapid pace of forest destruction and increasingly frequent water shortages had outpaced the government's ability to respond.

Fortunately, during that same period the occurrence of artesian (well) water was just being discovered on Oahu. The discovery of this resource was completely unexpected. It had never occurred to anyone that an abundance of groundwater could be found on a tropical island. In 1889 the first commercial artesian well was dug on the Ewa plain of the island of Oahu. Thus, began the era when artesian wells were dug on all of the islands. Forward-thinking government officials, sugar planters, geologists and water engineers quickly realized what the native Hawaiians had known for centuries; water and forests are inexorably linked. Destroy the forests, and water will disappear too.

By 1900 there was a general sense of panic among all residents of the islands as the springs and rivers that had sustained them for centuries dried up or became undrinkable due to sedimentation from denuded slopes. So the Terrirotial government turned to the U.S. Department of Agriculture (USDA) for help. The USDA dispatched E.M. Griffith, a forester with the USDA Bureau of Forestry to assess the condition and trends of Hawaii's forests, and to recommend a long-term strategy for addressing the threats to the forests. Mr. Griffith completed his assessment and recommendations in 1902. His findings and recommendations are included here in its entirety in order to provide us with a reference point documenting conditions and trends at that time, and to help us evaluate the effectiveness of his strategy.

GENERAL DESCRIPTION OF THE HAWAIIAN FORESTS 1902

A Report of U.S. Forester E.M. Griffith on Hawaiian Forests Presented at Yokohama, Japan, on March 5, 1902

Note: This following was copied in its entirety in July 1991 from a manuscript hanging (framed) in the main office of the Division of Forestry and Wildlife,

Department of Land and Natural Resources. Typographical adjustments were made mainly to the title and opening portion of the manuscript for cosmetic purposes. It is assumed that the manuscript was a talk given by Griffith in Japan in 1902. It seems that it was made up of excerpts from a letter to Dole written by Griffith. Note also that a discussion of Kauai's conditions is missing.

His Excellency, Governor Dole Honolulu, Hawaii

Dear Sir

I have the honor to forward herewith my report upon the condition of the Hawaiian Islands for your consideration. During the course of my preliminary examination, I visited the Islands of Oahu, Maui, Hawaii and Molokai, and paid particular attention to investigating the rapid destruction of the forests. I feel perfectly satisfied that the indiscriminate ranging of cattle in the forests have been very largely responsible for the present conditions, and that the sure remedy will be to fence off the forests and confine the cattle to the lower slopes.

Very respectfully, /s/ E.M. Griffith Assistant Forester Bureau of Forestry, U.S. Department of Agriculture

Formerly, the Hawaiian Islands were covered with dense and almost impenetrable forests which covered the steep ridges and deep canyons extending down to the narrow strip of arable land along the coasts and up to an elevation of 8,000 to 9,000 feet on the highest mountains. Ever-running streams and springs occurred on all the islands and the rainfall was fairly even and much heavier than it is today.

The old chiefs began the destruction of the forests by cutting enormous quantities of sandalwood but the blanks were soon filled up by other forest trees. The rapidity with which the native Hawaiian forest can be absolutely destroyed is truly remarkable and peculiar to the islands.

Dense forests which were absolutely impassable have, within the short space of five to ten years, been completely wiped out, so that at the present time, the soil is covered with a thick matting of grass. This comes from the fact that all the natives trees have a very shallow root system so that the least drying up of the soil immediately affects their vitality.

In nearly all sections of the islands, the undergrowth is composed largely of a dense mass of ferns which absorbs a very large amount of moisture thus affording a most favorable protection to the soil. Stock, particularly cattle, are responsible for the destruction of the forests in as much as they eat and trample down the ferns and other undergrowth, thus allowing the soil to become dry and often hardened under the full force of the hot tropical sun so that the roots begin to dry up and the trees naturally die. The worst feature, however, is that as soon as the undergrowth is killed out, the heavy Hilo grass immediately covers the soil and forms such a thick mat that it is impossible for seed to reach the soil and germinate. Then the life of the forest simply depends on how long the old trees can survive, for as soon as they fall the space which they occupied in the forest is taken possession of by the grasses.

Stock also destroy many trees by stripping off the bark and by injuring the roots which they have already exposed by trampling. Another very bad feature of pasturing stock in the forests is that they eat and trample down the young trees.

In a virgin forest where no stock have been allowed to graze, with very few exceptions, the only trees which are dying are those which would naturally do so from old age. The virgin Hawaiian forest is healthy, but where stock have destroyed the undergrowth the trees are dying in great numbers and are found to be attacked by insects particularly borers and the large girdling worms.

Insects can readily be collected by breaking off the limb of a tree or injuring it in some other way. The forests which are being attacked by insects are those whose vitality has been affected in some other way, usually by stock grazing. After investigating the matter very carefully I should say that stock are alone responsible for the rapid destruction of the forests. This is readily admitted by those who have studied the matter carefully and from an unprejudiced point of view; so that it seems essentially wrong that the welfare of the whole islands should be sacrificed to benefit the cattle business which forms such a small part of the commercial prosperity of the islands.

With a few exceptions the forests are only valuable in conserving the water supply and increasing the rainfall. Koa and algaroba are the only two species which occur in sufficient quantities to be of any considerable commercial importance.

Koa is a high grade cabinet wood with a very handsome grain and capable of a high polish while the algaroba furnishes the bulk of the firewood for the islands.

The algaroba grows very well at low elevations, particularly on the leeward side of Oahu and it would pay the government to plant it on

rocky or denuded areas which are unsuited to any form of agriculture.

The chief characteristic of the native species is their small size averaging only fifteen to twenty inches in diameter and thirty to 40 feet in height, together with the short length of clear bole. As a rule the side branches extend low down on the trunk which is accounted for from the fact that the trees have grown up in open stands.

Ohia occurs far more frequently than any other species and together with kukui, koa, mamane and hala forms the bulk of the forest, while the undergrowth is composed very largely of ferns.

As the forest of the Hawaiian Islands contain such a very limited amount of merchantable timber, the question of the best methods of lumbering does not enter into consideration; the whole problem is conserving the water supply which depends upon the preservation of the existing forests and restocking some of the denuded slopes either by natural reproduction or planting.

During the course of my preliminary examination the forest areas on the islands of Oahu, Maui, Hawaii and Molokai were examined, particular attention being paid to the condition of the forests along the headwaters of all streams.

Forest protection means not only increasing the rainfall but-more important still--conserving the water supply. Upon the right solution of this problem depends to a very large extent the future welfare and agricultural prosperity of the Hawaiian Islands. Sugar, the backbone of the islands, comprising over 80% of the exports, is absolutely dependent upon a plentiful and constant supply of water. The planter who does not depend upon the natural rainfall but irrigates his cane is apt to think that forest protection does not directly affect his business; but in reality he should be far more solicitous about the preservation of the forest than the planter who depends on the rainfall, for whether he is taking his water from a stream or an artesian well his supply will be very quickly affected by any disturbance of the forest cover along the important watersheds. Particularly is this the case where water is being taken from a stream whose headwaters lie within the forest belt, which is the case with most of the streams on the islands.

Fluming cane is by far the cheapest means of transportation, for this reason to many plantations it is of vital necessity that their supply of water be at least held constant and increased if possible. The stockman or farmer and those engaged in growing rice or taro are

also dependent, though not to the same extent as the sugarcane planter, upon a water supply which shall be fairly constant through all seasons of the year.

As previously stated, the denudation of the Hawaiian forests has been brought about to a very large extent by the practice of pasturing stock in the forests. Certainly this has been admitted by those who have studied the question and it is believed that fencing and the absolute exclusion of all stock is the only sure remedy. There is no necessity for abandoning the cattle business in order to protect the forests, but the cattle must be confined to the lower slopes.

It is especially important that fences should be built along the upper limits of the forest in order to prevent the wild cattle, sheep and goats which at present are ranging on the higher grass slopes from working down into the forests.

Wherever fences have already been built, the reclamation of the forests is as surprisingly rapid as their destruction when stock are allowed to range freely. As previously stated, the first effort should be to fence and protect those forests along the headwaters of all the important streams.

In order to place the work upon a thoroughly efficient basis, it will be necessary for the government, planter, ranchers and all others owning or leasing land upon which water is the chief consideration to cooperate and see to it that the forests are thoroughly protected.

- **A. Hawaii (the island)**. During the three weeks which were spent in the examination of Hawaii, I was enabled through the courtesy of the plantation and ranch managers throughout the island to visit all the districts and obtain a general idea of the conditions of the forests and what was being done to preserve them. In treating the forest problems of this island, the various districts will be considered in their order commencing with Hamakua.
- **A1. Hamakua**. This district extends from the northern slope of Mauna Loa, north to the sea and includes the greater portion of Mauna Kea which rises to an elevation 13,805 feet.

During the summer of 1901, a considerable portion of the forest lying between Mauna Kea and the coast on the north was burned over very severely. There is very little question but that most of the trees in this section are so badly burned that they will die and blow down, thus furnishing fuel for succeeding forest fires. The undergrowth had been destroyed by cattle so that the fire had swept; in fact, if this

had been a virgin forest with a rank undergrowth it would probably have been impossible to set it on fire. The forest had been so opened up by cattle that it died out thoroughly as is proved by the almost complete destruction of the humus so that the bare soil is now exposed. This latter result would be extremely favorable to the natural restocking of this burned area by self-sown seed but, very unfortunately, cattle are grazing in the forest and will destroy any young growth which may come up.

Within the present generation, forest fires have been almost unknown in the Hawaiian Islands but the indiscriminate pasturing of cattle in the forests makes their destruction by fire not only possible but extremely probable either through malice or carelessness in burning brush, cane trash or by camping parties.

A large part of the burned forest is on government land which has been leased until 1906, but it is extremely important that the government should induce the lessee, by an extension of time on his cane land lease or in some other way, to absolutely exclude cattle from this forest and protect it by fencing.

The forests in the remainder of the northern portion of the district of Hamakua are being rapidly destroyed by cattle, both wild and tame, so that the whole section within a few years will be a continuation of the Waimea plains unless adequate means are taken to protect the forests from cattle.

The wild cattle, sheep and pigs should be driven down from the mountains and the forests preserved by fencing.

On the north slopes of Mauna Kea, the mamane forest is spreading itself rapidly and appears to be holding out against the cattle, which is truly remarkable inasmuch as it is the only case of the kind which was seen anywhere on the islands. The mamane is a tough mountain tree and it is believed that it could be used to good advantage in restocking denuded slopes.

Between Mauna Kea and Mauna Loa the extensive plain or table land is covered with a rather broken growth of ohia, with scattering koa and mamane, while both mountain slopes are fairly heavily timbered.

On the whole the forests of Hamakua are in very poor condition and in some section fast disappearing solely on account of cattle grazing and the consequent forest fire. **A2. North Kohala**. The Kohala mountains which extend northwest and southeast through the district were formerly covered with very dense forests which were practically impassable except by cutting trail with cane knives. Cattle, however, have absolutely destroyed all the forests on the lower slopes and are rapidly denuding the forests on the higher slopes. In order to save any of the remaining forests, they should be fenced off and protected as soon as possible. On the lower slopes which have been absolutely denuded, artificial restoration will be necessary.

Some of the planters in this district have fenced their forests, but concerted action on the part of the government, planters and ranchers will be necessary in order to save the water supply.

A3. South Kohala. The Kohala mountains extend along the northern portion of this district, but here too the forests have been very badly damaged by the cattle. The central and southern portion include the Waimea plans and the open grazing country west of Mauna Kea. On all sides of Waimea the country is a rolling plain which is unquestionably suited to agriculture and should not be covered with forests. But this fine agricultural land will be almost useless unless a constant water supply is assured and this can only be accomplished by carefully protecting the forests on the Kohala mountains, particularly north of the village of Waimea.

At present, cattle are being run on this range and it is possible to ride through a large portion of the forest which a few years ago was impassable. Here, as elsewhere, there is no necessity for abandoning the cattle business but it should be carried on with much more system, with paddocks or an open range on the plains and the mountain forests protected from all grazing.

A4. Kona. This district is covered to a very large extent with lava flows a very restricted area of land suitable for any form of agriculture and nor running streams of any importance. Here the need of protecting the forests is not so pressing as in many parts of the island, as there are no headwaters of streams to be protected and the chief value of a large area of forest land will be to increase the rainfall and maintain an equable climate.

Here lava flows are gradually being covered with a forest growth composed chiefly of ferns and ohia which assist greatly in the rapid disintegration of the lava and the formation of a fairly rich soil. Such tracts are naturally suited to forest growth and as they are not, at present, capable of producing any more valuable crop, the should be

used as forest reserves. Cattle grazing on such lands does not yield sufficient returns to justify the destruction of the young forests.

On all parts of the island, the heaviest rains occur within the forests on the higher slopes of the mountains. Hence it is extremely important that the forest growth should be encouraged on Hualalai and the existing forest protected.

The combined area of the rocky slopes and the lava flows is considerable and the territorial government should see to it that these sections are kept under forests as they are almost worthless for any other purpose. Provided such a definite policy is adopted, it would be entirely safe to permit the clearing of all forest land for agriculture within the district.

A5. Kau. Formerly this was considered the driest district on the island of Hawaii, but since the plantations and ranches have commenced to preserve the forests by means of fencing out the cattle, the rainfall has increased materially.

Great credit is due the gentlemen who have been so far-sighted and liberal thus preserving a magnificent stretch of forest. Over 31 miles of protection fence have been built on the slopes of Mauna Loa back of the Pahala plantation and ranch, and within five years, since the fence has been constructed, the young growth, composed for the most part of ferns and ohia, has come up in such dense masses that it is almost impassable and the land is rapidly regaining its marshy character. This very satisfactory reclamation of a large forest belt which had been severely thinned out by both wild and tame cattle within a few years speaks for itself and points out the way both for the government, corporations and private owners who are all vitally interested in preserving the water supply.

Within this district, also notably, in the vicinity of the crater of Kilauea, are large tracts of land covered with lava and upon which the young forest growth which is struggling to gain a foothold and make soil should be absolutely protected. The growth of all species which are easily self-sown, particularly the pines, should be encouraged. This is especially true on the mountain slopes and higher elevations where it is important to conserve the heavy rainfall which, at present, is very largely lost through the rapid evaporation on soil which is exposed to the full force of the sun's rays.

A6. Puna. Puna is called the tropical district of the island and contains the truly magnificent forests of Olaa which are composed

very largely of tree ferns which are composed very largely of tree ferns which grow to a height of from 30 to 40 feet with a mass of smaller ferns as an undergrowth. In this connection the fact should be emphasized that a dense of ferns conserves the water more completely and gives it off more gradually than a more open forest of native trees. The ferns act as a sponge, absorbing an enormous amount of moisture and giving it off very gradually, especially if the ferns are in dense shade from an overhead or second-storied forest of trees.

Puna has a vast forest area and while large tracts are being cleared for sugar and homesteads, yet it is probable that there will be no diminution of the rainfall or water supply for fluming or irrigating provided the upper slopes of the forest are protected.

A7. Hilo. This district contains nearly all the running streams on the island of Hawaii and it is therefore more important to protect the forests on the headwaters of these streams than in nearly all other section combined. Most of these streams come from underground water which rises to the surface at a comparatively low elevation and are used extensively for fluming cane along the line of plantations which extend from Hilo to Hamakua. The loss or decrease in flow of these streams would be a severe blow to the plantations as they depend on fluming almost exclusively for the transportation of their cane to the mell. Above the plantations, the extensive forest covered slopes of Mauna Kea produce a very heavy rainfall which seeps through the aa flows and is carried to the lower levels by the more or less solid pahoehoe.

The lower edge of the forest is protected by the cane lands but wild and tame cattle, sheep and goats are killing the forest along the upper slopes and so gradually narrowing the forest belt. The rains which fall on the higher grass covered slopes and which is not lost by evaporation runs off very rapidly thus causing the small streams to overflow their banks after a very heavy rain without conserving any of it for the drier season when it is most needed.

Nearly all of this government land has been leased for a long term of years and the plantations in order to protect the headwaters of the streams must fence along the upper forest slopes and drive out or kill the stock which remains below the fence.

The government should assist the plantations in every possible way to protect the forests and incorporate in all future leases a provision that all important forest areas shall either be fenced by the lessee or all cattle absolutely excluded.

B. Maui. The forests on the island of Maui, upon the whole, are in a fairly satisfactory condition although in certain sections they are disappearing very rapidly. Nearly all the sugar plantations and the bulk of the arable land lies between Wailuku and Honomanu and here the forests have been seriously injured by stock grazing.

The sugar planters and farmers in this locality all depend upon irrigation, the water being taken from small streams which for the most part rise on the slopes of Haleakala. For many years, cattle were allowed an unrestricted range in the forests along the headwaters of these streams so that in many sections the forest is either dead of dying.

The almost total destruction of the undergrowth has allowed the soil to bake and harden thus causing the rainfall to run off rapidly with the resultant effect of very low water during the dry season. The Haiku and Spreckelsville ditches have prevented stock from ranging in the upper forests and so have formed a protection belt from Haiku to Honomanu. Along the line of the Haiku ditch the almost total destruction of the forests by stock is clearly shown; for whereas the forests on the upper side of the ditch, which have been protected, are very dense and healthy, those on the lower side, which have been open to grazing, are either almost destroyed or in a very unhealthy condition.

The district of Kula is also a striking example and, in order to save the little remaining forest, the cattle must be absolutely excluded. It is far easier and a much better policy to save the existing forests than to certainly destroy them by grazing and attempt to realize by planting a forest in some other locality.

Planting is extremely expensive, especially if the trees are set out very close together as must be done if a dense forest is to be secured which will act as a sponge and hold the water supply. Then too, a small amount of planting here and there does very little good and such expensive work will seldom be necessary in the islands if a common sense forest policy is pursued.

The government owns some very important forests areas on Maui along the headwaters of the streams and the upper slopes of the mountains which should be segregated and set aside as forest reserves. It will probably be advisable to build fences and necessary to determine which lands are suitable for agriculture and those which should always be kept under timber.

The forests in the Iao valley are very well protected and consequently show no signs of deterioration while the streams are maintained with a fairly even flow. The forests in the remainder of the district of Lahaina show very plainly the effect of grazing and must be much more carefully looked after in order to conserve the all important water supply.

The whole question on the island of Maui is protecting the existing forests; it is of the most vital importance to the plantations that these should be done at once and thus save the very large expense of artificial planting.

C. Molokai. Cattle, goats and deer have totally destroyed the forests upon the larger portion of the island of Molokai so that the western half is practically destitute of any tree growth. It is possible that the algaroba forests which have secured such a strong old along the coast near Kaunakakai may gradually spread over this end of the island. At present the soil is covered with a thin growth of grass which is apt to die down during the dry season thus allowing the top soil to cake and powder. Molokai is exposed to the full force of very heavy winds which are rapidly blowing most of this fine soil top soil off into the ocean. The algaroba will hold this soil, furnish splendid firewood and the bean pods make a very good feed for cattle during the dry season.

Planting in belts or strips is recommended on the western half of the island in order to form windbreaks and thus hold the shifting soils. The eastern half of the island including the entire Olokui section is by far the most important for here all the streams rise.

Cattle and deer, particularly the latter, have destroyed a large area of the forests but within late years their numbers have been greatly reduced by hunters who have been paid to shoot them.

The condition at present time is that the forest has been pushed back into the deeper and more inaccessible canyons and onto the highest slopes of the mountain. The effective watershed in respect to the conservation of the water supply has thus been greatly reduced and the careful protection of the remaining forests is an absolute necessity.

A small amount of fencing has already been done and the results are surprisingly satisfactory although the forests had been very badly denuded. The remaining fences should be constructed at once while there is still a small amount of undergrowth which will assist very materially in the rapid reclamation of the forests.

D. Oahu. Forest protection on Oahu is far more important than on any other island of the Hawaiian group on account of the large interests at stake and the great value of the water supply. Probably there is a greater daily consumption of water for irrigation purposes between Honolulu and Kahuku than on any equal area in the United States. The sugar plantations alone pump over 314 million gallons of water daily.

Both the Waianae and Koolau Mountain Ranges were formerly covered with a heavy forest growth extending down nearly to the shore line and in the center to the Waialua plains. But the indiscriminate ranging of cattle has resulted in the total destruction of all the undergrowth and trees on the lower slopes so that today the remaining forests are confined to the upper slopes and the more inaccessible canyons. Still the cattle continue to rapidly destroy the forest although in many cases the land and cattle owners are far more financially concerned in the welfare of the sugar plantations.

The water which is being pumped by the plantations to irrigate their cane is very largely that which falls within the forest belt on the higher slopes and gradually sinks to the artesian level. Consequently if the cattle and goats are allowed to destroy these forests, a considerable amount of water will be lost through largely increased evaporation on the exposed soil and the rapid run off.

There is a large amount of natural grazing land such as the Waialua plains and the lower slopes of the two ranges above the cane lands so that the necessary protection of the forest areas does not mean doing away with cattle business. There is also a large amount of fine agricultural land on the Waialua plains but these will be absolutely worthless unless the water supply is protected.

The reforestation of Tantalus by the Department of Agriculture and Forestry is an unusually fine piece of work very successfully carried out but it clearly demonstrates how difficult and expensive the reclamation of such land becomes when all the forest growth has been destroyed. It emphasizes the fact of how much easier it is to fence and protect the forests in time while a few trees remain to seed up the surrounding soil than it is to delay until artificial reforestation is necessary.

If the lower slopes of the forests on the Waianae and Koolau ranges are fenced off as soon as possible, the scattering trees will gradually reforest the slopes, the young koa, which at present is being eaten off and tramped by cattle, will come up and a small amount of planting of those areas which are absolutely denuded will be necessary. The



Figure 7. Nuuanu Valley in 1929. The hillsides were almost devoid of any trees. The bare patch of ground is the Oahu Country Club. Photo provided courtesy of Suzanne Case.

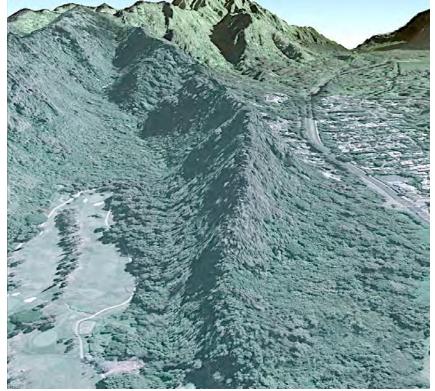


Figure 8. Nuuanu Valley today. Image courtesy of Google Earth.

fencing should have been done long ago and at present the reclamation of the forests will be very slow on account of the few seeds which remain and the mass of Hilo grass which has covered the soil and makes reproduction very difficult if not impossible.

So much of the government land on this island has been leased for a long term of years that the effective protection of the remaining forests depend upon the planters and other lessees will be benefitted. However, it is hoped that the government can assist in building the fences and they will appoint a ranger to patrol the forest lands not under lease and see to it that all cattle are excluded.

In future the forest areas on this island should never be leased for grazing purposes and the lessees of cane and agricultural lands should be obliged by the terms of their lease, to build stock fences and keep them in repair.

I recommend that a Forest Force be organized. In order to thoroughly protect the forest areas and carry out the forest policy of the government, the organization of a field force is extremely important. The following forest force which is similar to those in charge of the forest reserves in the United States is recommended, viz: A forest inspector who shall be a practical forester and have charge of all government forest land and direct the work of the forest rangers. Four forest rangers who shall have had some practical training in forestry, understand lumbering and tree planting, with rangers as follows: One on the island of Oahu; one on the island of Hawaii; one on the island of Kauai; one for the islands of Maui and Molokai.

Their duties should consist in patrolling all government forest land within their ranges and enforcing the terms of the lease, supervising the construction of all government fences, acting as fire wardens and taking charge of all the planting.

If thoroughly competent men are appointed, such a force should prove wonderfully efficient in protecting and building up the forest reserves.

~end~

Establishment of the Territorial Forest Reserve System

Griffith's report was well received, and his recommended strategy was implemented. In 1904, Frank S. Hosmer was hired as the first Territorial Forester. He immediately initiated a survey of those lands that should be designated as Forest Reserve and protected. By 1930, Hawaii's Forestry agency was staffed with trained forest rangers, tree nurseries were established, and a

Forest Reserve System was created that protected nearly 1,000,000 acres of public and private lands. Figures 7 and 8 show the results of the successful implementation of Griffith's strategy in in Nuuanu Valley.

The establishment of the Forest Reserve System was a true public-private partnership. All Territorial lands identified as important recharge areas were dedicated to the Reserve System, and private landowners volunteered their adjacent lands via "surrender agreements" with the Territorial government so that the Reserves could be managed as whole units regardless of ownership. Figure 9 shows the extent of the Forest Reserves in 1960 shortly after Hawaii attained Statehood. Tree propagation and planting were popular civic activities, and countless volunteers contributed to reforesting and protecting the Forest Reserves. That tradition continues to this day.

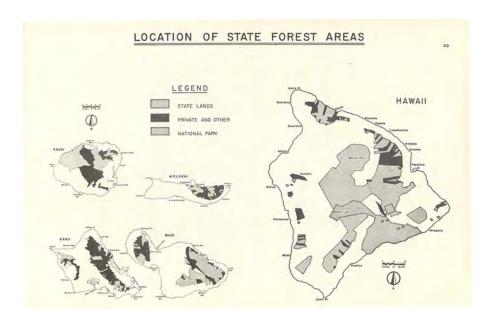


Figure 9. This map depicts the Territorial Forest Reserves immediately after statehood, but prior to the passage of the State Land Use Law in 1961.

During this same period the Boards of Water Supply on each island made it a policy to utilize artesian wells and forego the use of surface water or reservoirs. In 1932 Mr Ohrt, Manager and Chief Engineer of the Honolulu Board of Water Supply wrote "for the first time, the problem of Honolulu's water supply (can) be said to have been solved" 5. Today, nearly 100% of Hawaii's public water is withdrawn from wells. See Figure 10 and the following quote from the USGS regarding the importance of ground water in Hawaii.

"Ground water is one of Hawaii's most important natural resources. It is used for drinking water, irrigation, and domestic, commercial, and industrial needs. Ground water provides about 99 percent of Hawaii's domestic water and about 50 percent of all freshwater used in the State. Total ground water pumped in Hawaii was about 500 million gallons per day during 1995, which is less than 3 percent of the average total rainfall (about 21 billion gallons per day) in Hawaii. From this perspective, the ground-water resource appears ample; however, much of the rainfall runs off to the ocean in streams or returns to the atmosphere by evapotranspiration. Furthermore, ground-water resources can be limited because of water-quality, environmental, or economic concerns. Water beneath the ground surface occurs in two principal zones: the unsaturated zone and the saturated zone. In the unsaturated zone, the pore spaces in rocks contain both air and water, whereas in the saturated zone, the pore spaces are filled with water. The upper surface of the saturated zone is referred to as the water table. Water below the water table is referred to as ground water."

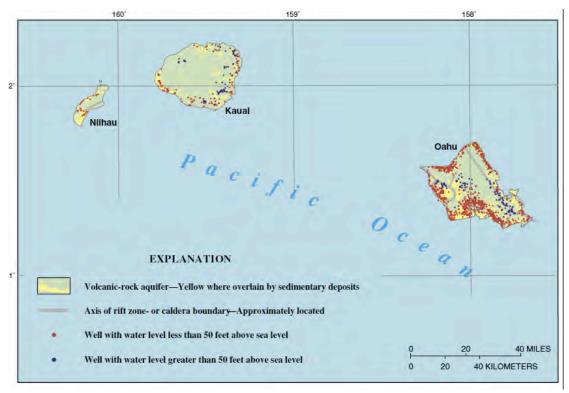


Figure 10. Location of artesian wells which are the source of water for the public water supplies for Niihau, Kauai and Oahu. Graphic courtesy of USGS.⁵

One Problem Solved, New Threats Emerge

But in solving one major problem, how to reforest denuded sloped, that generation of foresters were unwittingly sowing the seeds of our greatest threat to Hawaii's forests today; the introduction of highly invasive weeds, insects and disease. Early in the process, foresters noted that most native Hawaiian tree species could not become established in the hard, eroded slopes that had once been thriving forests. So they began to search the world for species that they could

effectively grow in mass quantities in tree nurseries and plant in the field. From 1904 through the 1960's there was a thriving rivalry amongst forestry professionals on who could bring in the most number of exotic trees and ornamental plants. Many of these species are of great value to us today both in our urban areas and in our forests.

Horticulturalists and botanical gardens did likewise. Nearly every species they tried could grow somewhere in Hawaii's many ecozones. Even today, one can harvest peaches, walnuts, plums, and apples in a fruit tree grove on the island of Hawaii. Tulip poplar (*Liriodendron tulipifera*) thrives on the uplands of Maui, and provides shade for orchids (*Dendrobium spp.*). Our botanical gardens are filled with spectacular flowers and foliage plants which do not have to compete with the other plants, animals, insects and diseases which evolved along side them in their native habitats. Some of our most pernicious weeds, including *Miconia calvescens* escaped from botanical gardens.

Like the water crisis of the 1880's, the problem of invasives snuck up on us, but now there is widespread consensus that introduced organisms threaten our land, our water, our streams and our coral reefs. The first forestry plan developed specifically for State Forest Lands in 1962, entitled "Multiple Use Program for the State Forest Lands of Hawaii" identified the values and threats provided by Hawaii's forests. That report identified only three threats to the forests; 1) the threat from fire, 2) the threat from insects and disease, and 3) the threat from animal damage.⁷ The threat from invasive plants, and the value of native biodiversity are not mentioned at all in the 1962 plan.

Since then, the rate of introduction for destructive new animals, insects and disease has increased dramatically with the advent of jet travel. The impact on our native species has been catastrophic. By 1992, a mere 30 years after that initial plan, it had become apparent that invasive insects, plants, algae and vertebrates were some the most significant threats to our forests, streams, coral reefs. Shortly after the passage of the Endangered Species Act, Hawaii earned the nickname "Extinction Capital of the Country" with approximately 35% of the Federally listed Threatened and Endangered Species. These topics are covered in depth in many of our Issues sections.

Hawaii's Second Statewide Assessment and Resource Strategy: 1961 Hawaii State Land Use Law and the Establishment of the Conservation District

Shortly after Hawaii became a state, the Hawaii Legislature passed the Hawaii State Land Use Law. All lands in the state were assigned to one of three "Districts" regardless of land ownership. The first and arguably most important district to be delineated was the "Conservation District". The main purpose for establishing the Conservation District was to assure the protection our forested water recharge zones into perpetuity and to limit conversion of these lands to other uses. The boundaries of the Conservation District closely followed the original Territorial Forest Reserve Boundaries shown in Figure 9.. Over time, the Conservation District has been further subdivided into subzones as the public and resource management agencies came to recognize the importance of protecting other values such as cultural uses guaranteed to native Hawaiians by the

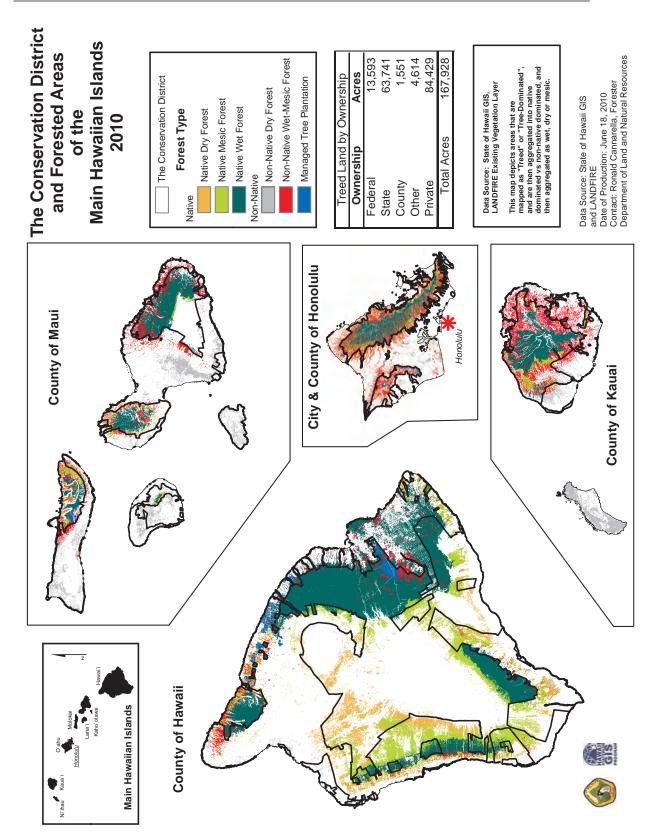
State Constitution, unique geological features, recreational opportunities, and exceptional native ecosystems.

Once the Conservation District boundaries were established, the next District to be determined was the Urban District. The purpose of the Urban District was to direct urban growth to appropriate areas. This was significant for Hawaii since the state does not have a municipal level of government. Lands not assigned to the Conservation District or the Urban District were lumped a broad category called the Agricultural District, with little regard to their potential for agriculture Several years later the Legislature established the Rural District with the purpose of preserving the quality of life for residents who chose to live in rural areas.

The Conservation District has been effective in preserving the regenerative capacity of our forested uplands. Since the enactment of the State Land Use Law, there have not been significant changes to the Conservation District. If anything, lands have been added to that district as the State has acquired private lands. However, there has been a tendency to reassign lands in the Agricultural District the Urban District. This process has been exacerbated by the loss of Hawaii's sugar cane and pineapple industries in the 19990's to countries where production costs for those crops are lower and environmental controls are less stringent. Nevertheless, the conversion of prime agricultural lands to residential communities and Oahu's "Second City" of Kapolei are of concern, since these lands will no longer be available for agriculture once developed. This issue is addressed in more depth in *Issue 4: Urban & Community Forestry and Issue 5: Climate Change/Sea Level Rise*.

Significance of the Conservation District

Planning and development in the Urban District, the Agricultural District and the Rural District are regulated by the county governments. However, all activities within the Conservation District are regulated by the Department of Land and Natural Resources. If a landowner wishes to undertake any actions on lands in the Conservation District they must apply for a permit from the Department of Land and Natural Resources. Thus, the Conservation District is essentially Hawaii's Priority Landscape Area for conservation so as to ensure that those lands continue to provide vital ecosystem services into perpetuity. Map A.5 shows the current boundaries of the Conservation District. It clearly depicts that the Conservation District has prevented the conversion of forests to other uses, but it also underscores the fact that many of our forested areas are dominated by non-native species. This map does not capture what is happening in the understory, where the rate of spread of invasive plant species is increasing at an alarming level in many areas. Using Miconia calvescens as one example, if a single mature seed bearing tree emerges from the understory, it will produce millions of seeds per year that will quickly be dispersed over the landscape by birds. In one sense, a single mature *miconia* is like a melanoma, that if left untreated, has the capacity to spread at an exponential rate and completely overtake all other overstory tree species, native or non-native'.



Map A.5: Lands in the Conservation District are permanently protected by state law to ensure that they continue to provide valuable ecosystem services into perpetuity. These lands are not at imminent risk from development, but they are increasingly dominated by non-native species.

The New Forest Reserve System: Unanticipated Consequences

With the implementation of the State Land Use Law, the definition of Forest Reserve changed. The State Forest Reserve System, which we currently have, includes only State owned lands in the Conservation District. The Division of Forestry (which subsequently added wildlife management and was renamed the Division of Forestry and Wildlife) was entrusted with management of the Forest Reserves, but had no jurisdiction over non-State lands that once comprised the Territorial Forest Reserve system. Federal and privately owned lands within the Conservation District were still subject to permitting requirements by the Department of Land and Natural Resources (DLNR), but over time, management activities became less coordinated. Landowners and federal agencies managed their lands according to their own priorities or other mandates. New threats to the forested uplands emerged. With increased access to the Hawaiian islands facilitated by jet travel and increased trade between the United States and Asia, the rate of introduction of dangerous invasive plants, insects and disease increased significantly.

As awareness of environmental issues grew during the 1970's, the passage of Federal and State Endangered Species Acts focused energy and resources on saving individual species from extinction. Hawaii established a Natural Area Reserve System (NARS) in 1975 specifically for the preservation of native ecosystems and cultural resources. The State's Natural Area Reserves were created by withdrawing lands representing the best examples of intact native ecosystems from the State Forest Reserve System, and an independent Natural Area Reserve Commission was established to develop policy for the NARS. The Division of Forestry and Wildlife established a new class of land managers specifically for the NARS. Although NARS and Forest Reserve System staff work side by side, their mandates differ. NARS staff focus primarily on conservation of biodiversity, and Forest Reserve staff focus on management of the Forest Reserve System under a multiple-use mandate.

Additional programs were created or transferred to DOFAW in the 1970's and 1980's. The regulation of hunting was transferred from the Division of Fish and Game to the Division of Forestry to create the Division of Forestry and Wildlife. In 1988, the State established the Na Ala Hele Trail and Access system to plan and maintain hiking trails and to provide access to public resources such as beaches, cultural sites and scenic forest lands.

Federal agencies including The National Park Service, The U.S. Fish and Wildlife Service and the U.S. Military, and conservation organizations such as The Nature Conservancy, acquired lands for the purpose of conservation. Over time, more and more lands were put into permanent conservation. Overall, the trend has been positive for conservation of our natural resource base. The conversion of our forest lands to other uses such as agriculture or urbanization has been effectively managed. But at the same time, land management for our most precious resources of water, native species, and cultural resources, became incrementally fragmented and uncoordinated.

A similar scenario was evolving with Hawaii's coastal waters. Conflicting activities increased as the visitor industry grew. Traditional native Hawaiian gathering rights which are guaranteed by the state constitution created conflicts between commercial fishermen, recreational uses such as surfing and use of motorized watercraft. Multiple state and federal agencies were charged with different mandates. At a national level, the same phenomenon was also taking place.

1990's; Hawaii's New Partnerships and Initiatives

Approximately one century after the establishment of the original Forest Reserve System we have seen the voluntary establishment of several new public-private watershed partnerships and other resource management alliances to facilitate cooperation among various land management agencies for the benefit of all. The same values that we inherited from the native Hawaiians, a deep love of the land, respect of community and a spirit of aloha and cooperation has lead to the establishment of these new successful and effective partnerships.

In addition to their ongoing activities, all of these stakeholder organizations were instrumental in helping DOFAW produce this document. The authors of this document interact on a daily basis with these organizations. The organizations are:

The Hawaii Conservation Alliance (HCA):



The HCA is an alliance of 15 Federal, State,

Hawaiian, and not for profit organizations engaged in the stewardship and conservation of Hawaii's natural resources. HCA has been a valued partner of DOFAW since its inception, and was instrumental in helping to produce this document. HCA is also helping the U.S. Fish and Wildlife Service to coordinate the establishment of their new Landscape Conservation Cooperative for the Pacific Islands region (PICCC) to address issues of climate change. Please see *Issue 6, Conservation of Native Biodiversity and Issue 5: Climate Change/Sea Level Rise for more information*.

The Watershed Partnerships: Public and private landowners voluntarily came together to



manage their lands for the purpose of recharging groundwater and surface water resources. After several watershed partnerships had established themselves, they came together to form an overall coordinating body, the Hawaii Association of Watershed Partnerships (HAWP). DOFAW helps coordinate the various watershed partnerships which have proven to be very effective at leveraging funding from various sources, both public and private. This issue is covered in more detail in Issue 1: Water Quality and Quantity.

Hawaii Invasive Species Council (HISC): The HISC is the statewide coordinating organization

for addressing the threat of newly introduced invasive species. Public and private agencies working on invasive species have founded to coordinate activities including the Coordinating



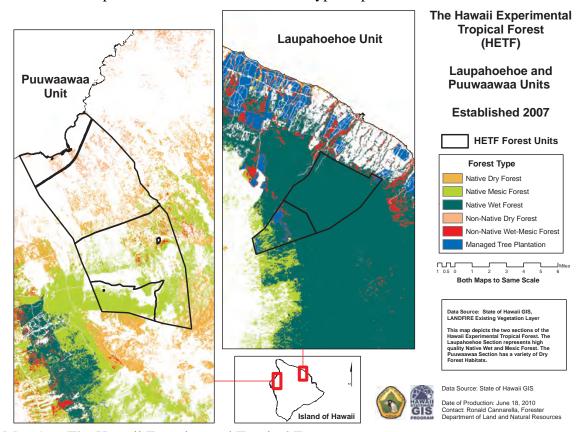
Group on Alien Pest Species (CGAPS), and the county-based invasive species committees ISC's). Like the HAWP, the HISC has been very effective at leveraging funding for the control of invasive species and for coordinating the activities of agencies working to protect Hawaii from dangerous invasive species that continue to arrive by air, sea and on the wind.

The Ocean Resources Management Plan (ORMP) Working Group: The Ocean Resources Management Plan (ORMP) was mandated by the Hawaii Legislature to provide a forum for

coordinating the numerous agencies and organizations involved in the management and use of Hawaii's ocean resources. Like the HCA, the ORMP working group consists of representatives of many Federal, State, County and private organizations.

Hawaii GZM Program
Coastal Zone Management

The Hawaii Experimental Tropical Forest (HTEF): The most recent comprehensive forest planning effort in Hawaii produced the Hawaii Tropical Forest Recovery Action Plan in 1994. One of the most significant outcomes of the action plan was the recognized need for an experimental forest in Hawaii to provide research opportunities addressing tropical island forestry issues. Two distinct forested areas, one representing wet forest systems and one representing dry forests were selected on Hawaii Island and in 2007 The HETF is a cooperative partnership between the U.S. Forest Service's Institute of Tropical Island Forestry and the DLNR. See Map A.6 for the location and forest types represented



Map A.6: The Hawaii Experimental Tropical Forest.

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Section References

- ⁵ Staff of the Board of Water Supply, City and County of Honolulu. (1948). "Conservation, Development and Protection of the Water Resources of the Honolulu Urban Area, Vol. 2". P 65.
- ⁶ USGS Hawaii District (2000) "Ground Water in Hawaii" Publication fs126-00.pdf. 6 pp.
- ⁷ Staff of the Division of Forestry (1962). "A Multiple Use Program for the State Forest Lands of Hawaii.

¹ noun. Traditional native Hawaiian land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (ahu) of stones surmounted by an image of a pig (pua'a), or because a pig or other tribute was laid on the altar as tax to the chief. Roughly analogous to the term "watershed".

² Hawaii Revised Statutes (HRS) Section 5-7.5, 1986

³ Day, A. Grove (editor) (1966). "Mark Twain's Letters from Hawaii." Honolulu, University Press of Hawaii.

⁴ For a detailed Timeline of Forestry in Hawaii refer to Appendix F.

Lessons from History: What Could Have Been

On tropical islands healthy forests and functioning watersheds can only be maintained through sound policies and effective management as demonstrated in this image of the border between Haiti and the Dominican Republic. During the time of Napoleon, Haiti was the most profitable european colony in the world; it produced half of France's foreign revenue from sugar cane cultivated in Haiti's rich soils by slaves imported from Africa. In 1791 the slaves



rebelled, and after a long and bloody revolution, all of the French fled the colony or were killed. Alarmed over the potential of the consequences of a successful slave rebellion, the U.S. imposed a trade embargo on Haiti, and the new country was left to fend for itself. With no unifying culture or tradition of land stewardship in their new environment, the Haitians had no effective government for centuries. Nevertheless, at the turn of the 20th century, Haiti still had 60% of its forests, but they were degrading rapidly due to overgrazing and harvesting wood for cooking.

The Dominican Republic, which shares the island of Hispaniola with Haiti, could see what was occurring and chose a different path to protect their forests. They banned logging, and subsidized gas stoves for cooking. The results of the differing approaches to land stewardship are evident in this image.



"What's the point of rebuilding Port-au-Prince, or moving it south, if we don't reforest Haiti? Where are they going to get their water from? Where are they going to farm? It makes no sense to rebuild a country that won't have trees. . . That would be a largely cosmetic solution if it doesn't go hand-in-hand with other measures to make the country environmentally viable. Haiti needs trees — and natural-gas or solar ovens — just as much as bricks."-Quote by Carlos Morales Troncoso, Foreign Minister of the Dominican Republic after returning from an international conference to kick off a 10-year plan for the reconstruction of Haiti after the devastating earthquake of January 12, 2010. Source: Andres Oppenheimer, The Miami Herald, Feb.4, 2010. Image courtesy of Google Earth.