



Last Stand

The Vanishing Hawaiian Forest



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Forests can change dramatically over relatively short periods of history. Hawaii's native forests evolved over millions of years to become one of the most remarkable natural assemblages on Earth. Yet since the onset of human arrival, 1,000 years ago, their history has largely been one of loss and destruction.

The worst damage occurred during the 19th century, when cattle and other introduced livestock were allowed to multiply and range unchecked throughout the Islands, laying waste to hundreds of thousands of acres of native forest.

The situation became so dire that the captains of government and industry realized that if the destruction continued there would be no water for growing sugarcane, the Islands' emerging economic mainstay. In response, the 1903 Territorial Legislature created Hawaii's forest reserve system, ushering in a new era of massive public-private investment in forest restoration.

Today, we reap the benefits of this investment but, ironically, no longer have a well-funded forest management program. Public investment in watershed protection has dropped precipitously, and once again the Hawaiian forest stands at a critical historical juncture.

The State of Hawai'i, which has stewardship responsibilities for half of the Islands' 1.5 million acres of forested lands, is currently spending less than 1% of its budget to protect all of its natural and cultural resources.

The knowledge and tools to protect our forests exist, but almost two decades of chronic budget shortfalls has left forest managers struggling to sustain watersheds, battle the nation's worst extinction crisis, and stem a silent and growing invasion of alien plants and animals.

Hawaii's native forests are among the Earth's biological treasures, sheltering more than 10,000 unique species. These forests supply our state with fresh water, protect our world-class beaches from destructive run-off and sediment, and are a vital link to the survival of Hawaiian cultural practices.

In the battle to defend these ancient forests, new public-private partnerships have formed across the state. These partnerships, which reflect a deeper understanding of the connection of native forests to water resources, offer perhaps the best hope for long-term forest preservation. Indeed, only by committing to a new era of public-private cooperation can we ensure the survival of the Hawaiian forest for generations to come.



Where Does

Hahai nō ka ua i ka ulu lā'au
Rains always follows the forest
— Hawaiian proverb

When you live on islands in the middle of a vast ocean, it's hard to put a price on the value of fresh water. Without it there is no life. The Hawaiian Islands lie in a relatively arid part of the Pacific, 2,500 miles from the nearest continental landmass, and the rainfall in the surrounding ocean is only 25 to 30 inches a year. Yet freshwater is abundant here. Where does it come from?

The answer lies in the convergence of winds upon the Islands' richly forested mountains. As warm ocean air moves inland, it is forced upwards by the mountainous terrain, cooling and condensing on its forested slopes. The upland forest captures water in the form of mist, fog, and rain, absorbing and releasing it into streams and underground aquifers.

Water collection is an essential function of all forests, but the Hawaiian forest seems perfectly designed by nature for the task. Its dense canopy provides an umbrella that intercepts rain. Its thick layered understory acts as a giant sponge, soaking up water. Its roots grip the mountain and anchor the soil, reducing erosion and enhancing surface water quality.

Water is the most important product of the forest, but its supply has always been so plentiful relative to our needs, and so cheap, that our awareness of its value has dimmed. Fresh water is not an unlimited resource, and its ready availability, quality, and sustainability are linked to the health of our forested watersheds. When we destroy our forests or allow our watersheds to degrade, we put our future prosperity and quality of life at risk.

Water Come From?

The Watershed: Nature's Collection Basin

A watershed is an area of land, such as mountain or a valley, that catches and collects rain water. Topography influences how water moves toward the ocean via rivers, streams, or via movement underground. In Hawai'i, our forested mountains are our primary watersheds. These areas, which contain both native and non-native forests, recharge our underground aquifers and provide a dependable source of clean water for our streams.



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A conserver of water

The Hawaiian rain forest is a great conserver of water. The tall, closed canopy shades out the sun, resulting in less water lost to evaporation and transpiration. The dense vegetation also blocks wind, which would otherwise pull moisture from the land. The many layers of vegetation blunt the erosive effects of rain, and once saturated, buffer the release of stored water, reducing immediate flow in wetter times, maintaining it in dry. Long after rain subsides, the forest delivers fresh water for human use.

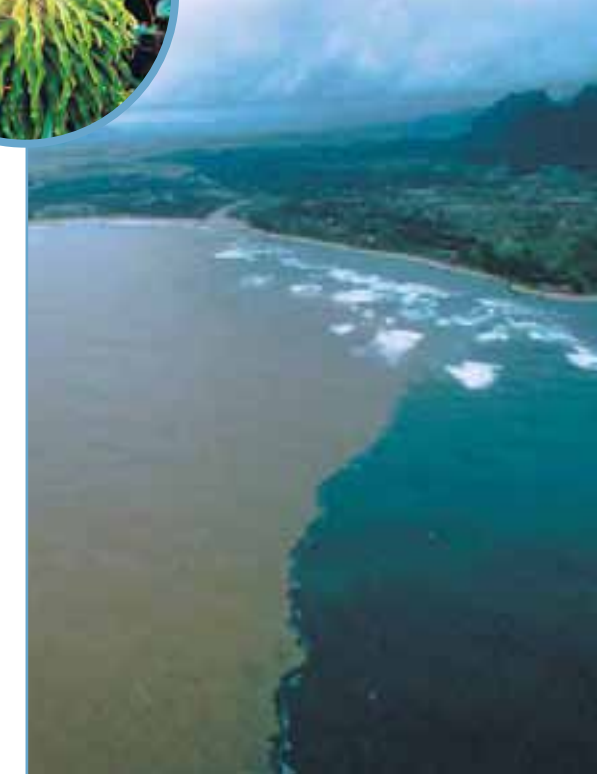


A reef saver

There is a direct correlation in Hawai'i between the health of our forested watersheds and the health of our reefs and beaches. Without a healthy forest to anchor the soil and temper the erosive effects of heavy rain, large amounts of sediment wash off our steep mountains and into the ocean, polluting streams, destroying coral reefs, and degrading coastal fishing resources.

Our defense against drought and flood

Perhaps the greatest value of the thousands of native species in our upland forests is the function that they perform together, as part of a complex, natural ecosystem. The balance achieved over the millennia has produced forests that can best weather the typical cycles of drought and flood in the region, and are uniquely adapted to the climate and soils of the mountain. Native forest ecosystems provide the best chance for a stable watershed, and it would be impossible to replace them at any price if they were destroyed.



The Hawaiian Rain Forest The Ultimate Watershed

A giant living sponge

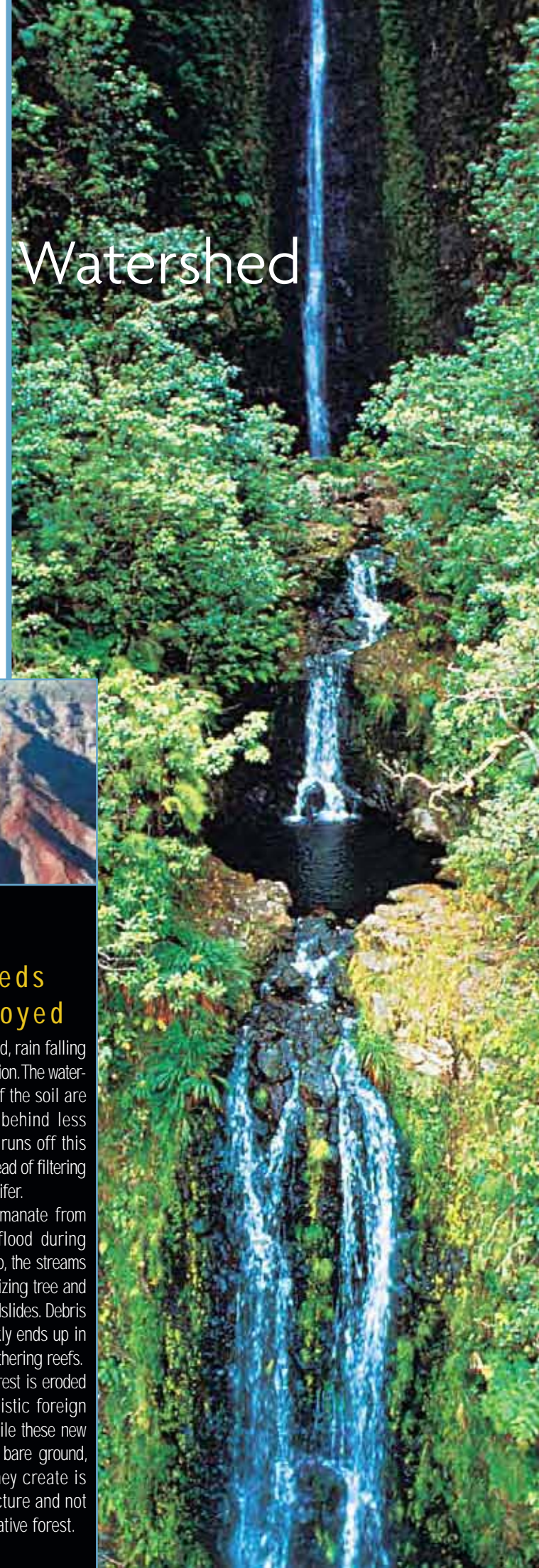
Millions of years of evolution have made the Hawaiian forest highly efficient at capturing and retaining water. Generally speaking, the more complex the structure of a forest, the more enhanced its watershed functions. The Hawaiian rain forest, with its marvelous multi-layered structure—tall canopy, secondary trees, shrubs and fern layers, ground-hugging mosses and leaf litter—acts like a giant sponge, absorbing water and allowing it to drip slowly underground and into streams. Even without rain, the forest can pull moisture from passing clouds. In Hawai'i, this interception can push water capture above and beyond total annual rainfall by as much as 30 percent.

When Watersheds are Destroyed

When a forest is degraded, rain falling on bare earth causes erosion. The water-retaining upper layers of the soil are washed away, leaving behind less permeable clays. Water runs off this impermeable surface instead of filtering down to replenish the aquifer.

Streams that emanate from deforested mountains flood during rains. When the rains stop, the streams run dry. The loss of stabilizing tree and plant roots results in landslides. Debris carried by streams quickly ends up in ocean coastal areas, smothering reefs.

When a native forest is eroded and damaged, opportunistic foreign species easily invade. While these new plants can help stabilize bare ground, the watershed cover they create is typically simple in structure and not as effective as that of native forest.





"Of all the places in the world, I would like to see the good flora of Hawai'i. I would subscribe fifty pounds to any collector who would go there and work."

– Charles Darwin, Naturalist

A Storehouse of Biological Riches



Charles Darwin never made it to Hawai'i, but other naturalists who did documented its astonishing natural diversity. From its sun-baked coasts to its snow-capped summits, Hawai'i is an evolutionary wonder, and its native forests a storehouse of biological riches.

Biologists today are still cataloguing what lives in the Islands' native forests, but already they have described a litany of wonders: happy-face spiders and carnivorous caterpillars; giant, flowering lobelioids and brilliantly hued song birds – even a remarkable native fish whose powerful pelvic fins allows it to scale thousand-foot waterfalls.

Hawai'i is home to over 10,000 native species, **more than 90% of which are found nowhere else in the world.** Science calls this phenomenon "endemism" – naturally occurring in only one place. High rates of endemism typically signal biological wealth. With more endemic species than any place of similar size on Earth, Hawai'i is biologically rich, and its native forests globally important.

Forests That Defy Naming

Hawai'i has almost as many types of native forest as there are U.S. states, including the nation's only tropical rain forests. 'Ōhi'a lehua, known for its bright red, orange, or yellow brush-like flowers, and koa, the highly prized native hardwood species, are the dominant forest types. But the diversity hardly ends there. The Big Island has its sub-alpine mamane forests, Lanai its dry forests of lapa and olopuu, Kauai its mist-shrouded swamp forests of dwarf 'ohi'a and lapa. Many of our forest types defy naming. Scientists are forced to call them "diverse mesic forests" because the list of constituent trees is so long and the mix so evenly blended that no one species can be called dominant. All total, there are 48 different native Hawaiian forest and woodland types and more than 175 different species of native trees, the vast majority of which are found nowhere else on Earth.



Why Biodiversity Matters

Born of volcanic soil and shaped by evolution, Hawai'i's native forests are rich storehouses of biological diversity. But what is biodiversity? And why does it matter?

"Biological diversity" refers to the variety of life forms on Earth, from genes to species to ecosystems. It is this genetic variation that allows living things to survive change by adapting to different physical and biological conditions.

Biodiversity plays a critical role in providing foods and medicines and is essential to maintaining the ecological processes upon which life depends. Plants, animals, and microorganisms are the cogs within natural systems that regulate climate and atmosphere, purify water and air, and maintain soil systems.

A biologically diverse forest ecosystem provides backup support for essential biological functions. Thus, in the same way that a diversified stock portfolio enables an investor to weather sudden shocks to the financial markets, a diversified ecosystem allows a forest to recover from natural disasters like drought, fire, and disease.

When we lose our native forests, we lose the important ecological services they provide, as well as a big part of the collective natural and cultural heritage of our Islands. The quality of our environment and our own quality of life are diminished. So, too, is the quality of life that we pass on to our children.

'Ōhi'a lehua

Signature Tree of the Hawaiian Forest

'Ōhi'a lehua can be found almost everywhere in native Hawaiian ecosystems and is the signature tree of the Hawaiian forest. Its scientific name, *Metrosideros polymorpha*, meaning "many forms," describes it well. 'Ōhi'a grows on sun-scorched lava and in rain-soaked bogs, and from just above sea level to the tree line at 9,500 feet. It can appear as a shrub or an emergent 100-foot tree. Its leaves can be smooth and glossy, thick and leathery, covered with a dense felt of hairs, and everything in between. Typically, two or more forms of 'ohi'a lehua will be growing next to each other, so different in stature, aspect, leaf and flower, that they look to be entirely different species.



A Natural Laboratory

for the Study of Evolution

Remote oceanic island archipelagos like Hawai'i are prized as unparalleled natural laboratories for the study of evolution. While species that colonize such island groups evolve in the same way as continental species, the process occurs much faster in an island setting and is more readily observable. Many of the phenomenon that Darwin documented in the fabled Galapagos Islands, another isolated island group, and which led to his theory of evolution, find even greater expression in Hawai'i's native forests.

"Hawai'i is the greatest place on Earth to be a biologist."

—Peter Vitousek, Stanford University; Member, National Academy of Sciences



When one species becomes many

Hawai'i surpasses the Galapagos Islands in the number and variety of species that evolved from a common ancestor, a phenomenon scientists call "adaptive radiation." Over time, and in response to their environment, species evolve to occupy diverse habitats. Thus, a single Hawaiian tarweed radiated into 36 species, a single species of tree snail became a genus of 40, a single finch proliferated into more than 50 species of honeycreepers.

Hawaiian lobelioids are considered one of the most spectacular examples of island evolution in flowering plants. An early botanist referred to Hawaiian lobelioids as "the peculiar pride of our flora" because of the amazing diversity of form and habitat taken by an adaptive radiation of more than 100 Hawaiian species, all derived from one original ancestor. Hawaiian lobelioids are the world's largest group of related plant species endemic to an island archipelago.



The marvels of co-evolution

When two interacting species, typically an animal and a plant, evolve together in ways that are beneficial to both, it's called "co-evolution." In the Hawaiian forest, honeycreepers and lobelioids co-evolved in a tight relationship of feeding. The long curved bills of certain honeycreepers fit precisely into the tubular flowers of many lobelioids. The fit of beak to flower is often so precise that the bird can draw nectar while maintaining a clear view of the world, alert for avian predators such as hawks and owls.

When herbs become trees

The original plants and animals that colonized Hawai'i found a place that was free of mammals, reptiles, and most other harmful predators and pests. As a result, many species evolved away their defenses — their thorns and odors and saps. Free to focus their energies elsewhere, many herbs and shrubs became trees, which helps explain why Hawai'i has such diverse forest types. Scientists call these and other similar evolutionary changes "adaptive shifts." The Hawaiian forest contains many examples, including the native nettle, or māmakī, which lost its stinging hairs, and 50 species of "mintless" mints.

Hawai'i has almost all of Earth's variation in climate, and most of its variation in soil.

Nature's University

There are few better natural laboratories than Hawai'i for the study of evolution, the role of individual species in an environment, and the complex relationships between organisms.

Not only is the Hawaiian archipelago well isolated, but as Darwin noted, its main islands are well isolated from each other. Each is a different geological age and boasts endemic species.

Hawai'i has almost all of Earth's variation in climate, and most of its variation in soil. Rainfall ranges from eight inches a year to more than 400 inches, and temperatures from near desert heat to freezing.

In addition, elevation changes are dramatic, rising quickly from sea level to summits approaching 14,000 feet.

All of this spectacular variation is found in a very small area, and it's almost all on one kind of rock, with ecosystems that are neatly organized — by lava flow, by elevation, by side of the mountain, by island. All of these factors work to produce extraordinary native forests that enable scientists to conduct research in ways that can be duplicated in few other places. Armed with this knowledge, scientists can measure biodiversity, assess its potential threats, and design methods to protect it.

The Roots of our Culture

Hawaiian cultural traditions reflect a long, close-standing relationship with the native forest. In ancient times, the forest was celebrated in chant, song, and dance, and its many gifts provided for the spiritual and material needs of the culture.

Water from the forest fed the *lo'i* (taro fields) in the lowlands and the fishponds along the coast. Woods from forest were used to make houses, canoes, weapons, and tools. Forest plants and herbs were gathered for healing and medicinal purposes, and the feathers of birds fashioned into brilliantly colored capes, helmets, and lei.

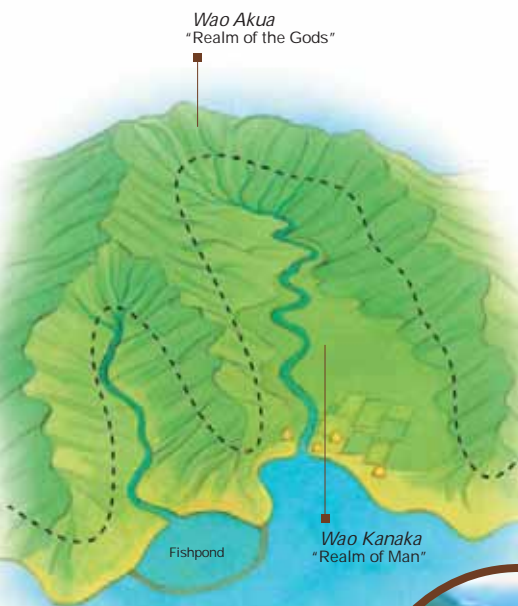
A deep reverence for the natural world permeated ancient life. Hawaiians saw themselves as part of, not separate from, nature. The land was the *'aina*, or "that which feeds," and its rich diversity helped shape and inspire the native culture. Today, the survival of an authentic Hawaiian culture is inherently tied to the preservation of the forest and the natural environment in which its traditions evolved. "To maintain our own beauty, we must maintain the beauty of the forest," says Kumu Hula Pua Kanahale. "If we cut down the forest, we cut down ourselves."

In the Forest Reside the Gods

The ancient Hawaiians saw gods everywhere in nature and worshiped a pantheon of natural deities. The upland forest was *wao akua*, the realm of the gods, and the trees were a physical manifestation of this spiritual realm. Entry into the forest was limited to a few consecrated individuals and involved a strict protocol, including an offering and a statement of identity and purpose. If the purpose was to collect trees, only a single tree or species could be collected at a time. The upland forest was sacred to Kū, the god of war, governance, and leadership. Ōhi'a lehua was the physical manifestation of Kū, and the taking of a large Ōhi'a was regarded as a sacred act, requiring a human sacrifice.

The Ahupua'a

Ancient Hawaiian life was based around the *ahupua'a* system of land management, which evolved to protect the upland water resources that sustained human life. A typical *ahupua'a*, or land division, was wedge-shaped and extended from the summits into the sea. As water flowed from the upland forest, down through the *ahupua'a*, it passed from the *wao akua*, the realm of the gods, to the *wao kanaka*, the realm of man, where it sustained agriculture, aquaculture, and other human uses. Water was a gift from the gods, and all Hawaiians took an active part in its use and conservation.



The Hawaiian Relationship to Nature

Ancient Hawaiians believed they were direct kin of the plants and animals that shared their world, and that both animate and inanimate things possessed spiritual power, or *mana*. They believed that beings with great *mana* could take on the form of other plants and animals, and that one's spirit might cycle through other living things after human death. In such a world, you could talk directly to the winds and rains and expect a response, or have the 'io, the Hawaiian hawk, as your ancestral guardian, watching over you from his perch in the forest.

As the youngest descendants among living family, humans had the role of caretakers, while the plants and animals, as the older siblings of the *'aina*, provided guidance. The saying goes: *He ali'i nō ka 'āina, he kauwā wale ke kanaka*. The land is chief, the human is but a servant.

Auwē!

In the early 1990s when the double-hulled Hawaiian voyaging canoe, *Hawai'i'loa*, journeyed to Tahiti, it was the first modern canoe of its kind created as much as possible from native materials. During its conception, however, the *Hawai'i'loa* hit a significant snag: a year-long search through the native forests of the Big Island identified only two living koa trees large enough for her hulls. For master navigator Nainoa Thompson, the discovery came as a shock, and he found that he could not, in good conscience, remove the trees from the forest. Instead, he traveled to the Pacific Northwest where he asked two tribes of native Americans for a gift of two large spruce trees. The experience instilled in Nainoa a strong conviction that preservation of the native forest is fundamental to Hawaiian cultural revival.



"Each time we lose another Hawaiian plant or bird or forest, we lose a living part of our ancient culture."

— Nainoa Thompson
Polynesian Voyaging Society

Wood – Mainstay of the Material Culture

Early Hawaiians possessed an especially detailed knowledge of the differing physical characteristics of wood. Trees such as Ōhi'a lehua, lama, and naio were often chosen for the basic framework of a house, while endemic hardwoods such as kauila, uhiuhi, olopuu, and koa were used to fashion spears, daggers, and clubs. Wiliwili, a wood of the dry forest, was known for its buoyancy and used for making fishing floats and surfboards, while koa was used for making canoes, bowls, containers, and tools. Wood played a singularly important role in all aspects of Hawaiian life. Shelter, agriculture, fishing, food preparation, storage, transportation, weaponry, and religion all included key structures or tools made from the different trees available in the native forest.



Hula and the Forest

In Hawaiian culture, Laka, the goddess of hula, is a forest deity, and so are the various plants that are sacred to the dance, including Ōhi'a lehua, maile, and palapalai ferns. When the ancients went to the forest to gather the materials with which they made their lei and costumes, they were mindful of a conservation ethic that is deeply rooted in old Hawaiian ways: Take from the forest only what you need. Chant and give thanks.



Featherwork in Old Hawaii

The feathers of many endemic forest birds were used to fashion capes, cloaks, helmets, and lei of spectacular beauty in old Hawai'i. Feather garments were a symbol of high social rank. They were worn only by royalty and connected the chiefs to the gods. The red feathers of the 'i'iwi and the 'apapane, and the yellow feathers of the now extinct 'ōō and mamo, predominated, but black, white, green, and other colors were also used. While featherwork may have contributed to the decline of many native birds, examples of the art form are among the most treasured objects to be found in the Pacific collections of the world's greatest museums.



Forests Under Siege

Deadly Invaders

Almost everywhere you go in Hawai'i, the native forest is under siege. Goats are eating their way up the side of the mountain in East Moloka'i. *Miconia calvescens*, the "green cancer," has a foothold on Maui and the Big Island. Feral pigs have spread into every watershed in the state.

Remote, oceanic islands are more vulnerable to ecological invasions than any other ecosystems. In Hawai'i, the damage done by feral cattle, pigs, goats, rats, weeds, wildfire, invasive insects, and other threats introduced by people has rendered the Islands' native forests among the most endangered in the world.

Since the onset of human arrival, Hawai'i has lost almost half of its native forest cover. While the historical impacts from agriculture, grazing, logging, and development are responsible for much of this loss, the greater threat today is the destruction wrought by invasive plants and animals.

Non-native species prey upon and destroy the habitat of native species, compete with them for food and habitat, and spread foreign diseases. Over time, they can transform the forests they invade, changing their structure, altering soil composition, sucking up scarce water, and increasing the risk of fire.



Wildfire

Except in active volcanic areas, fire is not a part of the natural life-cycle of native Hawaiian ecosystems, and only a few species regenerate after a fire, if at all. The void they leave is quickly filled by fire-adapted alien weeds, which increase the risk of future fires. This vicious cycle of destruction has played out on Moloka'i, which has seen four major fires in the last 20 years. Previous fires allowed flammable alien grasses to gain a foothold, and with each new fire they spread further. The worst fire covered 13,000 acres and destroyed some of the last remnants of lowland dry forest and rare species.



"The Green Cancer"

Miconia is recognized as the most invasive and dangerous alien plant species of Pacific Island rain forests. This fast-spreading Latin American plant casts a dense shade that kills everything beneath it, and its shallow roots cannot hold the forest floor's exposed soil. Over time a diverse, multi-layered native forest becomes a single-species *miconia* forest, prone to landslides. Incipient *miconia* populations on O'ahu and Kaua'i have been cleared, but more aggressive and sustained efforts are needed for Maui and the Big Island, where this weed infests thousands of acres.



Rototillers of the Forest

Wild pigs are widespread in Hawai'i's native forests. Where they root and trample, they destroy native vegetation, accelerate erosion, spread weeds in their droppings, and pollute the water supply with eroded silt, feces, and foreign diseases. Pigs eat the nestlings of ground nesting birds, and their wallows create breeding sites for foreign mosquitoes, which spread deadly diseases to Hawai'i's endangered forest birds.



Avian Peril

The Hawaiian archipelago once sustained at least 140 species of native birds. Seventy of those species are now extinct, and another 30 are endangered. For Hawai'i's remaining forest birds, introduced mosquitoes that spread avian malaria and other diseases are a primary threat.

"Far wiser to nip these pests in the bud before they bloom into expensive and formidable plagues."

— Honolulu Star-Bulletin



Koa Killer

Banana poka, a non-native vine introduced to Hawai'i from South America, has smothered over 70,000 acres of prime native forest. Hardest hit have been the state's precious koa forests, which supply Hawai'i's most renowned hardwood and support many rare birds and plants.



Dangerous Beauty

Using their antlers to girdle and kill native trees, axis deer wreak havoc on native Hawaiian ecosystems. Like other hoofed animals, they trample and eat native vegetation, spread non-native weeds, and greatly contribute to erosion. Axis deer have already proven their ability to destroy Hawaiian forests on Lanai and Moloka'i. They now threaten to do the same on Maui.



Rats!

Rats are widespread in Hawai'i and their impact on native forests is profound. Rats dine on native snails and raid the nests of native birds. They devour the seeds and fruits of native plants, as well as many of the native insects these birds and plants rely upon. In the end, they can shut down natural regeneration of our native species and contribute to their decline and extinction.



Cannibal Snail

In addition to rats, one of the greatest threats to Hawai'i's endangered tree snails is the carnivorous rosy wolfsnail. Native to Florida and Central America, the wolfsnail was introduced to Hawai'i in 1955 in a misguided attempt to control an agricultural pest, the giant African snail. Wolfsnails eat all snails regardless of size and have decimated native Hawaiian snail populations. Wolfsnails even devour their own species, giving them the common name "cannibal snail."



The Extinction Crisis

Hawai'i has the dubious distinction of being home to more than one-third of the birds and plants on the U.S. Endangered Species List. When spiders, snails, and insects are included, nearly 60% of Hawai'i's total native flora and fauna is imperiled, by far the highest percentage of any state. Destruction and the loss of forest habitat is the primary cause of species decline. If we are to preserve our remaining native forests and prevent further species loss, we must halt the continuing invasion of non-native plants and animals that is undermining the ecological stability of our Islands.

An Ounce of Prevention

State, federal, and private managers of Hawai'i's forests spend more than 75% of their resources to prevent the spread of alien pests, and repair the damages they cause. The best way to protect our native forests from further invasions is through enhanced prevention – stopping alien pests before they get here, or before they spread. For example, experts warn that Hawai'i could soon have established snake populations if several practical steps are not taken now. Hundreds of credible snake sightings have been reported in the Islands, and most of those snakes were free-roaming and not recovered. "Once you allow an invasive pest to become established, it's almost impossible to eradicate," says Maui scientist Lloyd Loope of the U.S. Geological Survey. "Expensive control costs are permanent. There's no putting the mongoose back in the cage."



What are Our Forests Worth?

Few places are more renowned for their natural environment than Hawai'i. Yet as a state we devote little money to its protection and essentially take for granted the many benefits it provides.

In the case of our forests, we pay no bill for the capture and filtering of rainwater that replenishes our island aquifers, no bill for natural erosion control and clear nearshore waters. We pay no bill for the uptake of carbon dioxide and the supply of oxygen, for the calming influence of green mountains on our psyche, or the shady trails we hike.

Contemplate the cost of replicating just one of these essential services through feats of technology or engineering and you begin to appreciate the contribution our forests make to our economy and quality of life.

Forested lands account for 1.5 million acres, or more than one-third of our state. But their value, and the value of the water they produce, is not included in conventional assessments of economic health. Value can only be indicated by price, and natural capital such as water enters into most economic discussions as a free resource.

A recent study by researchers at the University of Hawai'i took a bold stab at quantifying the goods and services derived from our forests. In determining that value, the authors examined the Ko'olau Mountains forest, O'ahu's primary source of water, and concluded that if there were complete deforestation due to a catastrophe, natural or otherwise, the value of the lost recharge to our aquifers would be between \$4.6 and \$8.5 billion.

When aesthetic values, water quality, climate control, biodiversity, and other forest services were calculated, the total value of the Ko'olau forest was estimated at between \$7.4 and \$14 billion.* Other forested watersheds around the state, such as those on East Maui, were found to be comparable in value.

Clearly, our forests are enormous economic assets. Just as clearly, the cost of maintaining them is not reflected in the price we pay for water and the other benefits they supply. Scientific research, tourism, fishing, forestry, agriculture, and biotechnology are all industries that directly benefit from or depend on our forests. To the extent that the state is involved in the management and pricing of its forest resources, such management and pricing should reflect their true value to our economy.

* "Environmental Evaluation and the Hawaiian Economy," prepared by the University of Hawai'i Economic Research Organization. Principal Investigator: Jim Roumasset.

Biodiversity and Scientific Study
Hawaii's native forests are one of the world's biological treasures and a natural laboratory for the study of evolution. Studies of Hawaii's native plants and animals have already revolutionized scientific understanding of how species evolve.



Aesthetics
The scenic beauty of Hawaii's rain-forested mountains is of great value to Island residents and a primary visitor attraction.



Biotechnology
Research into the genetics of the Islands' native biodiversity could have a significant impact on medical science, genetic engineering, and agricultural biotechnology.



Water
Water is the primary product of the forest and the lifeblood of our economy.



Cultural Preservation
The perpetuation of an authentic Hawaiian culture is closely tied to the preservation of our native forests.



Commercial Forestry
Hawaii's koa forests are the source of one of the world's most valuable hardwoods.



Total Value of Goods and Services from a Single Hawaiian Watershed
Water\$hed

● Amenity
● Estimated Net Present Value for Korolau Watershed

Ground water quality	\$4.5 - 8.5 billion
Surface water quality	\$83.7 - 394 million
In-stream uses	\$82.4 - 242 million
Species habitat	\$487 million - 1.4 billion
Biodiversity	\$660,000 - 5.5 million
Subsistence	\$34.7 - 131 million
Hunting	\$62.8 - 237 million
Aesthetic Values	\$1 - 3 billion
Commercial harvests	\$600,000 - 2.4 million
Ecotourism	\$1 - 3 billion
Climate Control	\$82 million
Total	\$7.4 to 14 billion

Clearly, our forests are enormous economic assets

The Lessons of History

“The future welfare and agricultural prosperity of the Hawaiian Islands depends on the preservation of the forest.”

– U.S. Forester E.M. Griffith, 1902

For the Hawaiian forest, 1903 was a watershed year. After more than a century of massive forest loss and destruction, the Territory of Hawai'i acknowledged that preservation of the forest was vital to the future economic prosperity of the Islands.

Urged by sugarcane growers and government foresters concerned about the vanishing woodlands, the Territorial Legislature created Hawai'i's forest reserve system, which became the basis for the largest public-private partnership in the history of the Islands. Today, more than a century later, we would do well to remember the wisdom our forebears so that future generations will not have to relearn the lessons of the past.

The First Hawaiians

When the first Polynesians arrived in Hawaii around the ninth century A.D, they found an archipelago of high islands rich in forest cover, with lush windward valleys in which to make a new home. They brought animals for food, as well as staples such as breadfruit, sugar cane, taro, and sweet potato. They also inadvertently brought rats, geckos, and the first introduced weeds.

The Hawaiians took care to protect the upland forests, which they considered *wao akua*, the realm of the gods. But they cleared much of the arable lowland forest to plant crops, constructed fish-ponds and taro patches in large, wet valleys, and hunted birds for food and ceremonial feathers. By the time of Captain James Cook's arrival in the Hawaiian Islands in 1778, much of the original lowland forest had been greatly altered by almost 1,000 years of intensive agriculture and the impacts of introduced animals, especially rats.

Western Contact: The Era of Sandalwood and Cattle

With European and American contact, changes to the Hawaiian environment accelerated and spread into the mountains. Sandalwood, exported to China for its fragrant aroma, became the Islands' first cash crop, with millions of trees harvested from the mountain forests. Livestock brought by Westerners – pigs, goats, sheep, and especially cattle – severely denuded the forests on all islands. Trading ships brought non-native songbirds and mosquitoes, introducing a key vector of avian malaria and pox to Hawaii's birds, which were soon eliminated from the warm, moist lowlands of all the islands. By the mid-19th century, the Islands' cattle and goat populations numbered in the hundreds of thousands. Forest destruction above Honolulu was so great it had all but stripped Nu'uauu Valley of its greenery, stirring concerns about the city's future water supply.



In the 1800s, trading ships brought mosquitoes to Hawai'i, which carried avian malaria that eliminated native birds from the Islands' lowlands.



The early Hawaiians were the first to establish agriculture and settlements in the native landscape.



Cattle and other livestock introduced with Western contact were allowed to multiply and roam unchecked throughout the Islands during the 19th century.

No Forests, No Water, No Sugar

As sugarcane overtook cattle as an economic force in the Hawaiian Islands, the influence of the planters in government increased. In 1892, a Bureau of Agriculture and Forestry was established, and with the support of the Hawaiian Sugar Planters' Association, the 1903 Territorial Legislature created a Division of Forestry with authority to establish forest reserves.

The early part of the 20th century saw a massive reforestation effort and the creation of 37 new forest reserves comprising nearly 800,000 acres of state and private land. A primary management goal was the exclusion of livestock from the native forests, as well as tree-planting and fire-control programs. Reforestation reached a peak in the late 1930s, when nearly two million introduced trees were planted annually in the forest reserves.

Although these efforts were well meaning, most of the trees were fast-growing introduced species such as eucalyptus. These non-native trees prevented catastrophic destruction, but they also produced sparse forests with fewer species than the complex, multi-layered systems created by native forests. By the advent of World War II, the forest reserve system included 1.2 million acres, more than a quarter of the Islands' total land area.

A Natural Heritage Worth Preserving

Today, Hawaii has the 11th largest state-owned forest and natural area reserve system in the United States, encompassing 700,000 acres. This is augmented by an equal amount of forestland in private ownership and 250,000 acres under federal jurisdiction. Our long-standing policy of watershed protection has resulted in dramatic improvements from the degraded conditions that prevailed at the turn of the 20th century, but much more work is needed.

Half of the Islands' unique tropical forests are already gone, and with them many of our native plants and animals. Nearly three quarters of the nation's plant and bird extinctions are from Hawai'i. The major threats to the Hawaiian forest are no longer logging or cattle ranching, but feral animals and invasive weeds. What's more, public investment in watershed management has diminished, and once again our forested watersheds are degrading. To halt this slide, public and private landowners have formed a network of "watershed partnerships" across the state. Dedicated to forest conservation, these partnerships represent an encouraging trend. But to succeed, they must be supported and funded, as they were at the turn of the 20th century.



The replanted forest: By 1940, millions of fast-growing, non-native trees had been planted throughout the Islands and the state forest reserve expanded to 1.2 million acres.



By recognizing the relationship between our forested mountains and a dependable supply of clean water, Hawai'i's sugar planters helped usher in a new era of forest restoration.



By the beginning of the 20th century, damage from goats and cattle had denuded the forest in Nu'uauu Valley above Honolulu, raising concerns about the city's future water supply.



Massive public-private investment in reforestation during the early 20th century replenished the water supply and fueled the era of plantation agriculture in Hawai'i.

Partnerships and the Forest

Partnering for Water The Future of

“Watershed partnerships are voluntary alliances of public and private landowners committed to the common value of protecting large areas of forested watersheds for water recharge and conservation values.”

As Hawaii’s extinction crisis accelerated in the closing decades of the 20th century, natural area managers began to look for ways to dramatically increase their protection efforts. The practice of setting aside individual forest parcels – whether as state forest reserves, private nature preserves, or national wildlife refuges – was clearly not enough. Threats such as feral pigs and invasive weeds did not respect parcel boundaries. To be truly effective, forest protection needed to occur across ownership lines, involve public and private landowners, and serve economic and environmental interests – just as it did at the turn of the 20th century.

In 1991, a model for large-scale forest protection was pioneered on East Maui. That year six public and private landowners and the county government formed the East Maui Watershed Partnership, a cooperative effort to protect a 100,000-acre forest ecosystem that is the island’s primary source of water. Recognizing that they shared protection of the watershed as a common interest, the partners agreed to pool resources and implement an active watershed management program across the entire East Maui landscape.

Today, the East Maui partnership has become the prototype for large-scale forest protection efforts in Hawai’i, and its success has spurred the formation of similar partnerships across the state. To date, more than 2 million acres of watershed and conservation lands in Hawai’i have been protected within these unique public-private partnerships. In the fight to save the Hawaiian forest, they represent our best hope for the future.



The Benefits of Partnerships

With ownership of forested lands in Hawai’i evenly split between public and private landowners, effective conservation can’t be achieved without the cooperation of both. By bringing public and private landowners together around a shared interest, such as watershed protection, these partnerships benefit forest conservation in a variety of ways.

- They exponentially expand our ability to protect forestlands quickly and efficiently.
- They allow for more comprehensive conservation planning.
- They enable land managers to construct fences and remove feral animals across land ownership boundaries.
- They make for more efficient use of resources and staff.
- They allow for greater unity in applying for public funding.
- They provide greater access to other funding opportunities.

Hawai’i Association of Watershed Partnerships

East Maui Watershed Partnership

ACRES 119,505
FOUNDED 1991
PARTNERS County of Maui; East Maui Irrigation Co., Ltd; Hana Ranch Partners, LLC; Haleakalā National Park; Haleakalā Ranch Co; State Department of Land and Natural Resources; The Nature Conservancy.

Three Mountain Alliance

ACRES 1,116,300
FOUNDED 1994
PARTNERS Kamehameha Schools, National Park Service; State Department of Land and Natural Resources; State Department of Public Safety; U.S. Fish & Wildlife Service; U.S. Forest Service; U.S. Geological Survey; The Nature Conservancy; USDA Natural Resources Conservation Service.

West Maui Mountains Watershed Partnership

ACRES 47,322
FOUNDED 1998
PARTNERS County of Maui; Ka’anapali Land Management Corp; Kahoma Land Company LLC; Kamehameha Schools; Mākila Land Company LLC; Maui County Department of Water Supply; Maui Land & Pineapple Co., Inc; State Department of Land and Natural Resources; The Nature Conservancy; Wailuku Water Company, LLC.

East Moloka’i Watershed Partnership

ACRES 30,136
FOUNDED 1999
PARTNERS Kalaupapa National Historical Park; Kamehameha Schools; Kapualei Ranch; Kawela Plantation Homeowners Association; Ke Aupuni Lōkahi Enterprise Community Governance Board; Hawai’i Department of Health; Maui County; Maui County Department of Water Supply; Moloka’i Soil and Water Conservation District; State Division of Forestry and Wildlife; The Nature Conservancy; USDA Natural Resources Conservation Service; U.S. Environmental Protection Agency; U.S. Fish & Wildlife Service; U.S. Geological Survey.

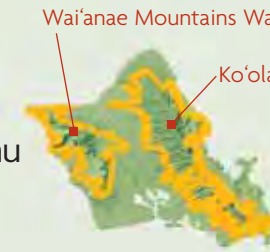
Ni’ihau



Kaua’i

Kaua’i Watershed Alliance

O’ahu



Wai’anae Mountains Watershed Partnership

Ko’olau Mountains Watershed Partnership

Moloka’i



East Moloka’i Watershed Partnership

Lāna’i Forest and Watershed Partnership

Lāna’i

West Maui Mountains Watershed Partnership

East Maui Watershed Partnership

Leeward Haleakalā Watershed Restoration Partnership

Maui



Kohala Mountains Watershed Partnership

ACRES 66,959
FORMED 2003
PARTNERS Kahua Ranch; Kamehameha Ranch; Kohala Preserve Conservation Trust; Laupāhoehoe Nui, LLC; Parker Ranch, Inc.; Ponoheo Ranch, Ltd; State Department of Hawaiian Home Lands; State Department of Land and Natural Resources; Queen Emma Land Company. ASSOCIATE PARTNERS Hawai’i County Department of Water Supply; The Nature Conservancy.

Kaua’i Watershed Alliance

ACRES 144,004
FORMED 2003
PARTNERS Ben A. Dyre Family Limited Partnership; Department of Water of the County of Kaua’i; Kamehameha Schools; Kaua’i Ranch, LLC; Lihue Land Company; McBryde Sugar Company, Ltd; Princeville Corporation; State Department of Land and Natural Resources; Grove Farm Company, Incorporated; State Department of Hawaiian Home Lands; National Tropical Botanical Garden. Partnership Coordinator: The Nature Conservancy.

Leeward Haleakalā Watershed Restoration Partnership

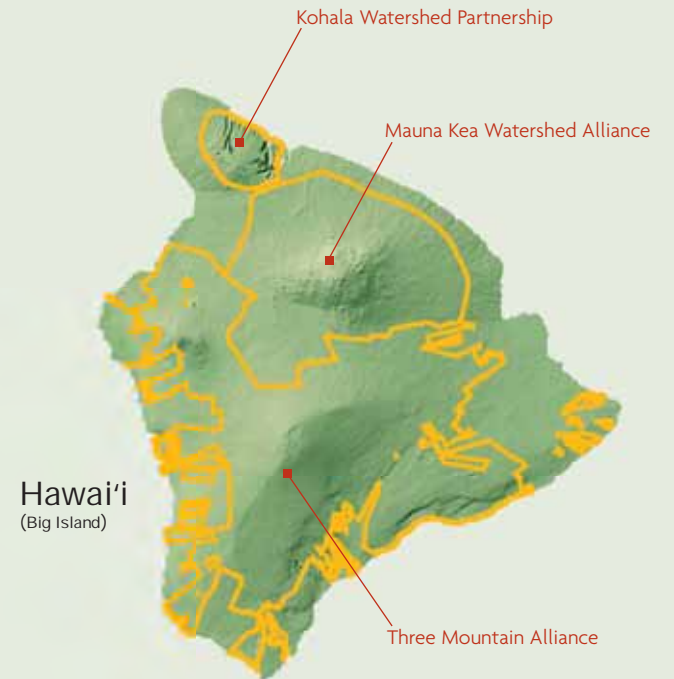
ACRES 43,000
FORMED 2003
PARTNERS Haleakalā National Park; Haleakalā Ranch; Kamaole Ranch; Kaonoulu Ranch; Kaupo Ranch; Nu’u Mauka Ranch; State Department of Hawaiian Home Lands; State Department of Land and Natural Resources; Ulupalakua Ranch; Jerry Thompson; John Zwaanstra.

Ko’olau Mountains Watershed Partnership

ACRES 98,737
FOUNDED 1999
PARTNERS Bishop Museum; City & County of Honolulu Board of Water Supply; Dole Food Company, Inc; Hawaii Reserves, Inc; Kamehameha Schools; Kualoa Ranch; O’ahu Country Club; Queen Emma Land Company; State Agribusiness Development Corporation; State Department of Hawaiian Home Lands; State Department of Land and Natural Resources; Tiana Partners, et al; UH Manoa/ Lyon Arboretum; U.S. Army; U.S. Fish & Wildlife Service. ASSOCIATE PARTNERS The Nature Conservancy; Pacific Cooperative Studies Unit; State Department of Health; U.S. Environmental Protection Agency; U.S. Forest Service; USDA Natural Resources Conservation Service; U.S. Geological Survey.

Lāna’i Forest and Watershed Partnership

ACRES 9,497
FOUNDED 2001
PARTNERS Castle & Cooke Resorts, LLC; County of Maui; Hui Mālama Pono O Lāna’i; Lāna’i Water Advisory Committee; Maui County Board of Water Supply; Moloka’i-Lāna’i Soil and Water Conservation District; State Department of Land and Natural Resources; Division of Forestry and Wildlife and Commission on Water Resource Management; The Nature Conservancy; USDA Natural Resources Conservation Service; U.S. Fish & Wildlife Service.



Hawai’i
(Big Island)

Wai’anae Mountains Watershed Partnership

ACRES 59,762
FORMED 2009
PARTNERS Gill-Olson Joint Venture; Honolulu Board of Water Supply; Ka’ala Farm, MA’O Organic Farms; U.S. Army Garrison, Hawai’i; U.S. Navy Region, Hawai’i; State Department of Land and Natural Resources.

Mauna Kea Watershed Alliance

ACRES 534,221
FORMED 2009
PARTNERS Kamehameha Schools; Kūka’iau Ranch; State Department of Hawaiian Home Lands; State Department of Land and Natural Resources; The Nature Conservancy; U.S. Fish & Wildlife Service.

Protecting Our Forests

A Plan of Action

Increase Dedicated Funding for Watershed Protection

Watershed partnerships are the most effective tool for the long-term protection of Hawaii's forested watersheds. These voluntary partnerships enable public and private landowners to share their expertise and resources, and efficiently manage our watershed forests across ownership boundaries. Secure, dedicated public funding is essential for landowners to make the long-term commitment of their lands and resources for the protection of this precious public resource. It also provides crucial state matching funds for other public and private grants. Currently, limited dedicated funding is provided through the State conveyance tax. Additional sources of funding for watershed protection should be considered such as a reasonable water fee and a share of the state tax on imported oil.

Prioritize Policies, Cooperation and Funding for Invasive Species Management

Invasive species such as weeds, feral animals, alien insects, and diseases pose the greatest threat to the health of Hawaii's native forests and watersheds. The Governor and the Legislature must mandate and fund invasive species policies, prevention systems and controls as high-priority issues that are core government functions, and coordinate their response to invasive species on a statewide level and across jurisdictional boundaries. The most cost-effective means of invasive species control is prevention – stopping invasive species before they get here or before they spread. Federal authorities need to support the State Department of Agriculture in its efforts to establish policies to protect Hawaii's unique environment. Sea and air carriers alike should support effective inspection and quarantine programs at ports of entry. And federal and state inspection agencies should work together in joint inspection facilities at air and sea ports to improve detection of pests while also facilitating the smooth movement of cargo in and out of the islands. While dedicated funding for inspections from cargo fees is now established in state law, dedicated funding is still needed for rapid response and control of invasive species that are here or are relatively new to the islands. State law should also be enhanced to restrict the movement of pests within and between islands.

Support Public and Private Efforts to Restore Hawaii's Native Koa Forests

Important native watershed forests are found on public and private agriculturally zoned lands on Hawaii island. Many of these forests, formerly dominated by Acacia koa, are barely surviving after generations of harvesting and land clearing. Reforestation can restore many of these forests, providing ideal watersheds, habitat for native species, as well as sustainable forest products. Public cost-sharing and tax incentives are needed for private landowners to invest in long-term reforestation, and federal and state laws need to encourage long-term commitment to native habitats on private lands. In cooperation with ranchers, agriculturally zoned state lands that are currently leased for marginal pasture operations should be returned to koa forests.

Fund Management of State Conservation and Agricultural Lands

Hawaii's Department of Land and Natural Resources (DLNR) receives less than 1% of the state general fund budget to manage nearly 1 million acres of natural lands, as well as Hawaii's marine resources. The state is a key player in all watershed partnerships, and increased funding for management of state lands is critical for successful large-scale watershed management and endangered species protection. Many agricultural lands under DLNR jurisdiction also contain important public trust forest resources that need management.

What You Can Do to Protect Our Forests

Volunteer: Take part in rebuilding a trail, planting trees, or other forest-related activities.

Take a hike. Get outdoors and learn about the forest through experience.

Pack out your trash. Keep the forest free of litter.

Do not release animals such as chameleons, tree frogs, parrots, rabbits, cats, and other invasive species into our forests. They can multiply quickly and cause irreparable harm.

Be careful not to introduce non-native plants and animals into Hawaii, and report sightings of any animals that don't belong here, such as snakes and lizards.

Conserve water. Turn off the hose and tap when not in use.

Keep fires out of Hawaiian forests. Our native ecosystems are not adapted to fire. Regeneration can be difficult, and, in some cases, impossible.

Protect our streams and drinking water. Don't dispose of dirty liquids, plastics, trash or other debris in streams.

Learn more about Hawaii's unique natural heritage and how to preserve it for future generations. Read, surf the web, and enjoy the outdoors.

Mālama Hawaii. Teach others, especially your children, to care for Hawaii's environment.

Fund Federal Natural Resource Management and Research Programs

Some of the nation's most critically endangered species are found on the federal lands in Hawaii, at national parks, wildlife refuges, and on military bases. Many of these federal lands are the core protected areas for watershed partnerships, and their management influences surrounding state and private lands. Additional federal funding is needed for fencing, animal control, and weed eradication, as well as for research on threat management and forest restoration. Ultimately, these investments will provide public and private landowners with more effective and efficient management tools.

Resolve Conflicts between Game Mammal and Native Forest Management

One of the greatest challenges to protecting rare native species is the continued presence of pigs, goats, deer, and sheep in native forests. These introduced game mammals reduce populations of endangered species by eating, trampling, and degrading native habitats. One potential solution is to finance and implement a strategy that serves competing needs. In some cases, this means removing game mammal populations from intact native forests that harbor rare species. It also means increasing quality hunting opportunities by improving habitat that support game mammals, opening new areas to hunting, and increasing the number of game animals available.

Reconnect Native Hawaiian Values that Support Forest Management

Management policy to preserve Hawaii's forests should not ignore the traditional Hawaiian style of ahupua'a (mountains-to-sea) management. The East Moloka'i Watershed Partnership, for example, is managing the upland forest to protect the island's primary source of water, and in so doing reducing the runoff and sediment in the farming and fishing communities below. Ahupua'a management strengthens people's ties to the land and empowers local communities to protect their natural resources. It should be supported and expanded throughout the islands.

Increase Public Awareness and Involvement in Natural Resource Protection and Management

Effective forest protection requires strong political and financial support and partnerships among public and private landowners. But increased public support is also needed. The larger community is not sufficiently aware of what is at stake in the potential loss of the state's native forests, nor what it can do to prevent this loss. Programs to develop environmental education curricula for Hawaii's schools should be expanded so that young people can learn about the island's native forests and ecosystems, and the opportunities for saving them. University programs and more hands-on experience are essential to train conservation professionals for the future. And expanded public access and volunteer opportunities are needed to involve local communities in forest protection and management projects.



The Nature Conservancy
Protecting nature. Preserving life.™

The mission of The Nature Conservancy is to protect the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

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