WATER AND THE LAW
IN HAWAI'I

Lawrence H. Miike, M.D., J.D.
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Aquifers, Streams, and Things

The Hawaiian Islands are formed by a hot spot in the earth's crust, oozing and gushing lava over millions of years, until land finally breaks the surface in this remotest part of the Pacific Ocean. The new island continues to build, while it slowly moves off the hot spot, carried away on the tectonic plate in its northwesterly journey. Mountains of lava continue to raise the altitude of the island, some crashing back into the ocean, some crumbling into soil, where seeds from the innards of a bird or floating in the sea or wind find their way. The now-vegetated islands become accidental refuges of wandering or windblown birds and insects, which slowly colonize the islands. Even as their flora and fauna are becoming established, the islands are already beginning their long periods of decline and are being replaced by other newly forming islands, some above the ocean's surface, others still below.

Lehua, Ka'ula, Nihoa, Necker Island (Mokumanamana), French Frigate Shoals (Mokupāpapa), Gardner Pinnacles (Pūhāhonu), Maro Reef (Nalukakala), Laysan Island (Kauō), Lisianski Island (Papa'āpoholo), Pearl and Hermes Atoll (Iholoikauaua), Midway Atoll (Pihemanu), and Kure Atoll (Kāne-miloha'i): These too are Hawaiian Islands, once as verdant as Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lāna'i, Maui, Kaho'olawe, or still-growing Hawai'i. Archeological remains reveal the presence of humans on Nihoa and Necker (Mokumanamana), eventually abandoned as their freshwater sources dried away. But now, through millions of years of erosion, compression, and subsidence, they are but fragments of their former selves. The most northerly islands, from Laysan Island north, are now wholly limestone, their land mass above the surface of the ocean originating in coral reefs resting on deeply submerged volcanoes rising as much as 15,000 feet from the ocean floor. On Midway Atoll, the volcanic base can be found from 500 to 1,200 feet below the sandstone. Even in the newest of the islands, Hawai'i, which is still growing
through active lava flows, beach deposits have been found 4,500 feet below sea level, where Kilauea volcano formed on the shoulder of Mauna Loa.²

**Surface and Groundwater Resources in Hawai‘i**

**Groundwater**

The Hawaiian Islands are formed by so-called shield volcanoes, “because of a fancied resemblance in profile to that of the round shields of early Germanic warriors.”³ Their eruptions are relatively gentle, spreading thousands of thin layers upon overlying layers of lava as the land was built up. When lava flows on land (“aerial flows”), these layers are thinly bedded, highly clinkery, and highly permeable. Each flow averages 12 to 15 feet in thickness and only rarely reaches as much as 50 feet.⁴ Clinker is irregular lumps of lava of the ‘a‘a type, which has a very rough, spiny, or rubbly surface. Pāhoehoe lava has smooth, billowy, or ropy surfaces. Most flows emerge from the vent as pāhoe-hoe, changing to ‘a‘a as they advance downslope.⁵ In contrast, flows extruded in water are likely to be more massive, less clinkery, and less permeable.⁶

The highly permeable basalt of the volcanoes became the repository for vast reservoirs of fresh water. Instead of running off the surface into the surrounding ocean, between 30 and 80 percent of an island’s rainfall percolates downward into the basalt, depending on the climate and rock permeability.⁷ On average throughout the Islands, one-third runs off into streams, one-third evaporates and transpires (after being taken up by plants), and one-third recharges the underground water.⁸

Fresh water is lighter than salt water and floats on the salt water, and they mingle at their interface. Because there is no physical barrier between the fresh water above and the salt water below, their interface consists of a “zone of transition,” where the water gradually turns from fresh to salt. In wet areas where the rate of recharge may be high, the zone of transition may be very thin, as the rapid downward movement of fresh water flushes out the salt water that has diffused upward. In dry areas, the salt water may diffuse so far that the entire aquifer is brackish.⁹

Frictional resistance as the water moves laterally through rock into the ocean causes the water to pile up until it attains a sufficient hydraulic head to overcome the friction. This piling up of water above sea level and pressing down of water onto the salt water below result in the fresh water taking on the shape of a biconvex lens, with both top and bottom bulging outward. This freshwater lens may be so large that it can rise hundreds of feet above sea level, and the weight of this enormous amount of fresh water pushes the lens farther onto the salt water so that for every foot of fresh water above sea
level, there is an additional 40 feet below. The fresh water that sits on the salt water is known as basal groundwater, or the Ghyben-Herzberg lens (or the basal lens), after the Dutch and German scientists who independently discovered the principle of freshwater flotation on salt water in coastal regions.

Data on the Pearl Harbor aquifer from the Waipahu area are shown in Figure 1, which indicates the transition from fresh to salt water with increasing depths. The top of the freshwater lens is between 15 and 20 feet above sea level. The top of the transition zone between fresh and salt water begins at 412 feet below sea level, defined as the point where the chloride content of the water reaches 250 mg/L, or the maximum concentration of chloride in potable (drinkable) water. The midpoint of the transition zone, where the water is half the concentration of salt water (9,500 mg/L versus 19,000 mg/L), is located at 738 feet below sea level. (Chloride content in Figure 1 reflects the conductivity method actually used—expressed in microS—which can be converted into chloride concentrations.)

By convention, the thickness of the freshwater lens is measured down to the midpoint of the transition zone. Thus, in Figure 1, the freshwater lens extends from 15–20 feet above sea level down to approximately 740 feet below sea level, approximating the 1:40 ratio described earlier. However, recall that the freshwater lens has the shape of a biconvex lens, with both top and bottom bulging outward. Thus, as the edge of the lens approaches seaward, one would expect the lens to be thinner. The Pearl Harbor aquifer in fact is thicker inland than seaward, with the midpoint of the transition zone at a depth of 700 feet or more below sea level in its far inland portions and only 300 feet at a point measured closer to the shore.

As the shields of lava poured out and cooled, cracks would form in the shields. Subsequent flows would sometimes erupt below the shields, not just from the surface volcanoes, and these subterranean flows would extrude their way upward through the cracks. Because these later flows were under high pressure from the weight of the old lava beds above, they are dense and impervious to water. The result is an intermingling of large deposits of porous basalt, saturated with percolating rainwater, restricted in their lateral flows by hundreds of dikes resulting from the later flows of dense lava into the cracks of the older basalt. As a result, "the ground water occurs in interconnected reservoirs that are impounded by dikes in the rift-zone areas or [in] reservoirs that are dike free in the flanks of the volcano."

Groundwater can occur at high elevations because of the presence of these dikes. The vertically confined water rises until leaks through the dikes reach equilibrium with the rate of recharge from the rain above. These dike-impounded, high-level groundwaters can result in columns of water hundreds
of feet high on the windward sides of the islands, where the moisture-laden trade winds from the northeast bump up against cliffs several thousand feet high and disgorge their moisture as rain.

Along the coast, alluvial and marine sediments formed during periods of volcanic inactivity are compressed into a caprock that impedes the seaward movement of the fresh water into the surrounding ocean.

![Figure 1. Transition from fresh to salt water: Pearl Harbor aquifer, Waipahu Deep Monitor Well, October 2002. Source: Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawai'i.](image-url)
The various characteristics of Hawai‘i’s aquifers are integrated in a synthesized version in Figure 2. Dike-impounded, high-level groundwaters are partially connected to the adjacent basal aquifer through breaks in the dikes. Caprock formed from compressed sediment impedes the seaward flow of fresh water.

Caprock is not limited to coastal areas and may occur inland, even at high elevations, consisting of a bed of dense lava, volcanic ash, or even alluvium. Where the dense layers of packed sediment cover the freshwater-saturated basalt, rainwater collects over this caprock, forming relatively shallow reservoirs of water, or perched groundwater. Caprock can even occur at great depths. For example, University of Hawai‘i researchers have encountered a layer of soil 1,000 feet below sea level that marked the transition from Mauna Loa lava flows to Mauna Kea rock. The soil layer has a lower permeability than the lava flows, acting as a caprock to trap water beneath it that has percolated down from the upper slopes of Mauna Kea, and it is forcing that water well below sea level and causing it to discharge at offshore submarine springs. The researchers estimate that it takes 1,800 years or so for the water that falls on the surface of Mauna Kea to flow down into the interior of the mountain and then travel out to the point below the drill site. Another drill site 2 kilometers inland from the first revealed that the water table of this caprock aquifer was above sea level,
because fresh water flowed out of the borehole at the rate of 2,000 gallons per minute at an elevation of about 30 feet above sea level.\textsuperscript{15}

In reality, of course, these separations are imperfect, with variable impermeability and many faults or cracks in them. Salt water encroaches on the aquifer at or near the seashore, and springs of fresh water may flow near or even off the shore. Inland, freshwater springs flow through breaks in the impervious rock. Similar breaks connect the aquifers, sometimes so much so that withdrawals from one also significantly drain the other. In these cases, although different aquifers are involved, they act as one “hydrologic unit” (defined in the State Water Code as “a surface drainage area or a ground water basin or a combination of the two,” HRS Ch. 174C, § 174C-3).

The functional measurement of a groundwater deposit is its “sustainable yield.” The State Water Code defines this as “the maximum rate at which water may be withdrawn from a water source without impairing the utility or quality of the water source as determined by the commission.”\textsuperscript{16} If more than the sustainable yield is withdrawn, the freshwater lens begins to shrink, the zone of transition between fresh and salt water may begin to shift upward, and the aquifer is in danger of degrading after a period of time—that is, yielding less fresh water than it was originally capable of producing. Once degradation occurs, even ceasing all withdrawals may not return the aquifer to its previous point of equilibrium until decades have passed, if at all.

But estimating an aquifer’s freshwater volume, its point of equilibrium, and its sustainable yield is not an exact science. Aquifers do not always come with clean boundaries and are often connected through breaches in the relatively impervious rock that separates them. There is no clear demarcation between fresh water and the surrounding and underlying salt water but rather a transition from one to the other.

The equilibrium on which estimates of sustainable yields are based relies in turn on estimates of recharge and natural outflows. The answers to these questions are aquifer-specific.

These reservoirs accumulate the infiltration from rainfall, store it temporarily, and leak it steadily to abutting basal reservoirs or to streams cutting into the dike-impounded reservoirs. In areas where the dike-impounded reservoirs are near the land surface, some discharge is directly to evaporation and transpiration. The reservoirs, owing generally to the high capacity of the surface rocks to absorb rainfall and their own large capacity to store water, serve as holding tanks that effectively reduce the great variability in rainfall recharge.
The factors controlling recharge in the rift-zone areas include the rate and persistency of rainfall, absorptive characteristics of the land surface, permeability of the reservoir rocks, dike pattern and dike density, slope of land surface, forest cover, and evapotranspiration. The factors that control recharge also control discharge in the rift-zone areas. Where the conditions are ideal for recharge, discharge of ground water to the surface is nonexistent. Where the conditions are least ideal, recharge is limited and most of the ground water is discharged to the surface as springs. The discharge of dike-impounded water, either below the ground or on the surface, becomes potential recharge to downgradient water bodies.

Where the rift-zone extends to the sea, the mode of discharge to the sea depends largely on the density and trend of the dikes and the permeability of the rocks at depth. The surface discharge would probably be high and the underflow low where dikes are numerous and parallel the shore or where the permeability of the near-shore rocks are low, or both. The discharge mode would be reversed if dikes were sparse and normal [i.e., perpendicular] to the shore and the permeability of the rocks high.

Whether or not the estimated sustainable yield actually can be obtained from an aquifer depends on how withdrawals are managed. The ends of well shafts placed too close to the top of the freshwater lens may result in enough "dimpling" when pumped at the wells' capacities that the top of the lens is drawn down, reducing the amount of water that can be withdrawn to a quantity below what was expected. Wells placed too close to each other can have the same dimpling effect, or they can draw up the zone of transition so that there is saltwater encroachment in the water being pumped. Well shafts placed too deeply can have the same saltwater encroachment, either by drawing up the zone of transition or being placed directly in water that is too salty in the first place.

Thus, sustainable yield is more a management concept and approach than a quantity independent of how withdrawals are managed. Given this state of affairs, sustainable yield is best viewed as a benchmark, with increasing caution as withdrawals approach it and with the impacts of withdrawals on the aquifer's equilibrium gauged by monitoring the aquifer.

Monitoring includes deep monitor wells, water-level observation wells, spring chemistry data, and water use/chloride data from production wells. Deep monitor wells measure the size and stability of the freshwater lens. Such monitoring can follow the stability of the transition zone. Figure 3 summarizes twenty years of data on the Pearl Harbor aquifer at the Waipahu Deep
Figure 3. Elevations of the top of the transition zone and the midpoint of the transition zone at Waipahu Deep Monitor Well. Source: Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawai‘i.

Figure 4. Water levels at Waipahu Deep Monitor Well. Source: Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawai‘i.
Monitor Well. During this period, the top and midpoint of the transition zone have remained very stable, indicating little or no deterioration in the freshwater basal lens.

Data on water levels of the Pearl Harbor aquifer at Waipahu are summarized in Figure 4. During the ten-year period shown, the water level has remained fairly steady, varying between 15 and 20 feet above sea level.

Data from springs and production wells are analyzed for chloride and contaminants such as nitrates and pesticides/herbicides that may have worked their way down into the aquifer.

Mitigation measures and optimal use strategies, in order of increasing difficulty and cost, include (1) redistributing pumping usage across existing wells; (2) altering pumping schedules; (3) decreasing pumping capacity; (4) backfilling high-chloride wells (i.e., sealing off the lower portions of the wells’ pipes so that water is withdrawn from higher up); (5) abandoning high-chloride wells; (6) spacing well fields farther apart; and (7) relocating wells farther inland.

Streams

The caprock sealing off aquifers and the dikes impounding high-level groundwater leak from the pressure of the stored water, resulting in springs and seeps. These groundwater contributions comprise a stream’s base flow—the minimum flow that will be present even in times of prolonged drought. An approximation of the base flow is the index of reliable flow—the flow equaled or exceeded 90 percent of the time.

Figure 5 summarizes the relationship between the dike-impounded reservoirs and streams in the Kāne‘ohe subzone of the Ko‘olau Range on the windward side of O‘ahu. Toward the interior, the mountains are dike-free, gradually increasing in the frequency of dikes toward Kāne‘ohe Bay (from left to right in Figure 5). As a result, the water table in the beginning of the dike zone is higher than in the dike-free zone. The streams begin at the base of the cliffs at a point lower than the water table, and leakage and overflow from the upper dikes comprise the streams’ initial flows. The streams rest on a bed of alluvium, which acts as a cap on the water reservoir below. Older, more compacted alluvium occurs at the higher elevations, while more recent, less compacted alluvium occurs lower down. The high frequency of dikes in the lower dike complex impedes the flow of water from the upper marginal dike zone, so most of the discharge of reservoir water into the streams through the less compacted alluvium occurs near the upper edge of the dike complex.

On the windward side, where the distance between the cliff face of the mountains and the shore is relatively short, streams are typically short,
straight, steep and “flashy,” rising and falling several feet in a matter of hours when it rains heavily. The windward streams drop rapidly in elevation from 1,000 to 2,000 feet in only a few miles, and heavy rains can easily swell the streams’ flows by ten times or more in a matter of hours. For example, the base flow of a stream might be 10 million gallons per day (mgd) from mountain springs and erosion into the caprock of an underlying aquifer. In a heavy rain, the flow might easily increase to 130 mgd in a matter of hours and continue for days or weeks at a level higher than the base flow as gravity draws the water absorbed by the land in the stream’s watershed into the streambed.

Thus the most reliable measurement of a stream’s flow is its base flow, measured at the point of maximum base flow in the stream’s downward course. Suppose a stream drops 1,000 feet from its mountain source to the ocean, with springs from the dike-impounded, high-level groundwater contributing 5 mgd at 1,000 feet elevation and discharges from the underlying

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aquifer lower down contributing another 5 mgd by the time the stream drops down to 250 feet elevation. In this example, the stream’s flow at its origin is 5 mgd; there is a gain of 5 mgd in base flow by 250 feet elevation; and the base flow remains the same until the stream empties into the ocean. The stream’s base flow is therefore 10 mgd at 250 feet elevation, the point where base flow reaches its maximum.

Because of the relationship between a stream’s base flow and groundwater, a stream’s base flow may be affected by withdrawals from the contributing groundwater sources. A tunnel may be bored into the dike-impounded, high-level groundwater, or wells may be drilled and water pumped from the underlying aquifer. If the water table is lowered enough to affect the point where the high-level groundwater and/or aquifer contribute to stream flow, the sources of the stream’s base flow may be diminished or even completely dried up.

Base flow represents stream flow during prolonged dry periods, when contributions from rain and runoff are at a minimum. Average flow, while also measured at specific elevations of the stream, includes rain and runoff. The same example illustrates the difference. During dry periods, the stream will have a flow of 5 mgd at its origin, rising to a maximum of 10 mgd at 250 feet elevation. Then a heavy rain occurs over two days. At the origin, the flow is still 5 mgd, but suppose rain and runoff add another 40 mgd between the origin and 250 feet elevation, so that the measured flow at 250 feet elevation is 50 mgd (5 mgd plus 5 mgd plus 40 mgd). Between 250 feet elevation and the mouth of the stream, suppose another 80 mgd has been added by rain and runoff, so at the mouth, the stream is carrying 130 mgd as it flows into the ocean. (Assuming an equal amount of rain over the stream’s entire watershed, additions lower down in the watershed would generally be larger, because the stream’s catchment area would be larger lower down in the watershed.) If we average these two flows, the average flow is 5 mgd at the origin (5 mgd plus 5 mgd divided by two), 30 mgd at 250 feet elevation (10 mgd plus 50 mgd divided by two), and 70 mgd at the mouth (10 mgd plus 130 mgd divided by two). Comparing base flow with this two-measurement average flow results in the following: (1) At the origin, both base and average flows are 5 mgd; (2) at 250 feet elevation, base flow is 10 mgd and average flow is 30 mgd; and (3) at the mouth, base flow is 10 mgd and average flow is 70 mgd.

As rainfall varies not only from day to day and month to month but also from year to year, measurements over many years would be averaged to dampen the disproportionate effects storms would have on average stream flows. Furthermore, over the course of these years of measurements, the lowest measurements would best approximate the stream’s base flow. Confidence
that the lowest measurement represents the base flow would be increased if there were multiple measurements that resulted in the same lowest number.

There is also a difference between base and average flows from a resource management perspective. Average flows reflect the water that actually will be flowing and available for offstream uses (adjusted for storms, when the stream flows are greatly in excess of what can be used or needed). On the other hand, base flow is the key measure in striking a balance between offstream and instream uses. If a stream’s flow is to be further reduced to accommodate additional offstream uses, or if the stream is to be wholly or partially restored, the key ingredient, insofar as stream flow is concerned, is the minimum amount of water that is flowing in the stream at any time. (There are many variables in addition to flow that affect the ecological viability of a stream.)

Establishing a base flow commensurate with stream preservation or restoration does not mean that the only water available for offstream use is the difference between the prior and newly established base flow. The purpose of the newly established base flow is to ensure (or at least enhance the chances of) preservation and/or restoration. And the actual amount of water that would be available for offstream uses includes the large amounts of water that contribute to the stream’s average flows.

The preceding discussion is illustrated by Figure 6, the flow of Waikāne Stream in Windward O’ahu for the years 2000–2001. Measurements were taken at 75 feet above mean sea level, the point in the stream where base flow reaches its maximum. Daily mean flow varied from a low of 1.5 cubic feet per second (cfs) to a high of 114 cfs in this two-year period (1 cfs is approximately 0.65 million gallons per day [mgd]). For the period 1960–2001, the highest daily mean flow was 868 cfs and the lowest daily mean flow was 1.1 cfs, a difference of nearly eight hundred times. The index of reliable flow—the flow equaled or exceeded 90 percent of the time—was 1.8 cfs in 2000, 1.9 cfs in 2001, and 2.1 cfs (1.37 mgd) for the period 1960–2001. In contrast, the annual mean was 4.42 cfs in 2000, 3.87 cfs in 2001, and 8.47 cfs (5.51 mgd) for the period 1960–2001.

Figure 6 summarizes daily flows. While the variability in flows is dramatic, the flashy nature of many of Hawai‘i’s streams is shown even more dramatically in Figure 7, which summarizes flows taken every fifteen minutes on July 23, 2001, in the Wailuku River on the island of Hawai‘i. During a storm, flow rose dramatically from 3 cfs to over 65 cfs in less than two hours, then dropped nearly to baseline in less than an hour, only to spike to 60 cfs and drop back to baseline in the next hour. (The Parshall flume measuring flow had a capacity of 65 cfs, so when flow exceeded 65 cfs, the gauge continued to read, but the measurements were lower than the actual flow.)
Stream Ecology

Little is known about the relationship between stream flows and the ecological systems of streams. Too many extraneous factors have been introduced to enable a one-to-one causal relationship between flow and stream viability. Watersheds have radically changed with the introduction of nonindigenous trees, shrubs, and grasses, altering the absorption characteristics of the watersheds' soil and the amounts and patterns of water released into the streams. Introduced fishes and crustaceans not only compete for space and food with their indigenous counterparts, they also have brought with them parasites and other diseases. Yet some streams that have been severely degraded through reduced base flows, changes in their watersheds, and introduced aquatic species still support viable and thriving native species, while other comparable or even less degraded streams are nearly devoid of native life.

What are the characteristics of Hawai‘i’s native stream life that lend themselves to such paradoxes?

Excluding insects and other invertebrates, there are only nine native species in Hawaiian streams—five fishes, two crustaceans, and two mollusks. All are *amphidromous*, meaning that these species migrate from their freshwater habitats to the ocean and then return—but neither migration is immediately associated with spawning. The following are similar but still distinct: (1) Salmon are *anadromous*—migrating from the ocean into fresh water to spawn; (2) certain freshwater eels are *catadromous*—migrating from fresh water to the ocean to spawn; (3) *oceanodromous* species migrate from one part of the ocean to another; and (4) *potadromous* species migrate from one freshwater habitat to another (both *oceanodromous* and *potadromous* species usually migrate from deeper to shallower waters to spawn). All five classes are included in the broader term “*diadromy*,” or any life cycle for an aquatic species that includes two migrations during its lifetime.24

*Amphidromy* is illustrated by the spawning behavior of one of the fish, *Awaous guamensis*, known to the Hawaiians as ’o’opu nākea. This fish inhabits

![Figure 7. Wailuku River, island of Hawai‘i. Source: Synergies, Inc., submittal to Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawai‘i, for Stream Channel Alteration Permit number SCAP-HA-47-Paragraph (9), Honolulu, Hawai‘i, August 6, 2001.](image-url)
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the lower to middle reaches of the stream and migrates to estuarine areas nearer the ocean to spawn. After the eggs hatch, the fry are swept into the ocean, where they reside for about five months, at which time the juveniles return back to the stream, probably through cues associated with fresh water that cause the juveniles to orient shoreward, move into the stream mouth, and proceed upstream to the areas occupied by the adults. The return of the juveniles (which the Hawaiians called *hinana*) is not specific to the streams in which they were hatched, so streams devoid or severely depleted of *'o'opu* need not be stocked when they are restored. The Hawaiians have a saying:

*Ka i'a ho'opā 'ili kanaka o Waimea.*

*The fish of Waimea that touches the skin of people.*

When it was the season for *hinana*, the spawn of *'o'opu*, at Waimea, Kaua'i, they were so numerous that one couldn't go into the water without rubbing against them.

These native species are closely related to other stream species on tropical islands, the probable source for their colonization of the Hawaiian Islands, and they are of such ancient ancestries that it is speculated they had already been established in Kaua'i's streams before the island of Hawai'i emerged from the sea. In fact, their ancestries are so old that eight of the nine native species (four of the fishes, both crustaceans, and both mollusks) are endemic—that is, they have differentiated to the point of being found nowhere else in the world—and the remaining fish is indigenous—native to the Hawaiian Islands but found elsewhere.

The fishes belong to two families: (1) the Gobiidae, in which the ventral fins are fused into a disk that allows the fish to cling to rocks and thus to live in swiftly flowing water and/or to climb; and (2) the Eleotridae, in which the ventral fins are unfused. The Gobiidae include *Lentipes concolor*, *Sicyopterus stimpsoni*, *Stenogobius hawaiicensis* (all endemic), and *Awaous guamensis* (also known as *Chonophorus guamensis* or *Awaous stamineus*) (indigenous). The eleotrid is *Eleotris sandwicensis* (endemic). The crustaceans are the shrimp *Atyoida bisulcata* and the prawn *Macrobachium grandimanus* (both endemic). The mollusks are the patelliform (shaped like a kneecap, i.e., univalved, like an abalone) *Neritina granosa* and *Neritina vespertina* (also known as *Theodoxus vespertinus*) (both endemic).

The Hawaiians knew these fish as *'o'opu*, the crustaceans as *'opae*, and the mollusks as *hihiwai* (or *wi*) and *hapawai*. They were intimately familiar with these stream animals, which were an important part of their food supply. Hawaiians had many proverbs for these sources of food.
The fish glogged for in the streams.

The 'o'opu, often caught by groping under rocks and hollow places in a stream.

The fish fondled by the palm of the hand.

When it was the season for the hinana ('o'opu spawn), they were so numerous that they could be scooped up in the palm of the hand.

The fish that warms the clumps of grass.

Mountain shrimp, which cling to weeds and grasses along the banks of streams when a cloudburst occurs in the upland.

The fish of the stream that requires no bait.

The wī, a freshwater shellfish.

Hawaiians had many names for the same fish, not only because different names were given to the same fish in different localities, but also because the same species sometimes had different physical appearances.

*Lentipes concolor* is an 'o'opu that reaches a maximum size of 5 inches and uses its ventral suction disks to reach its habitat in the middle to upper reaches of the stream. It can be found above the highest falls in the islands because of its climbing ability. The Hawaiians called it *bi'ukol* (raw tail), *bi'uo'ula* (red tail), or 'alamo'o (for its resemblance to a mo'o, or lizard). "It is a sign of bad luck to find one in a net when fishing for other fish for it keeps other fish away and must be thrown out of the net with an exclamation of disgust if one expects to be successful with the catch."

*Stenogobius hawaiiensis* is an 'o'opu that also reaches a maximum size of 5 inches and inhabits the estuary and lower reaches of the stream. The Hawaiians called it *naniba* (avoidance), and it was usually not eaten.

The other three 'o'opu were relished by the Hawaiians. *Sicyopterus stimpsoni* reaches a maximum size of 7 inches and inhabits the middle reaches of the stream, preferring fast water. The Hawaiians called it *nāpili* (*nōpili* on Kaua'i). It was a favorite fish of the *kābuna* (priests), who used them in the
mawaeowae or weaning ceremony of the firstborn, “so that blessings might cling to the child. It was also used in house-warming feasts, so that luck would cling to the house.”

He nōpili ka i'a, pili pa'a ke aloha.
The nōpili is the fish; love clings fast.

Said of the freshwater goby (ʻoʻopu) of the nōpili variety, known to climb waterfalls by clinging fast to the wet stones. It was used by kāhuna in hana aloha sorcery.

Eleotris sandwicensis reaches a maximum size of 12 inches and inhabits the estuaries and lower reaches of the stream. The Hawaiians called it by many names, including ʻakupa, ʻokube, ʻapobā, and ʻoau or ʻowau. The name for the young after they have passed the hinana stage is the name doubled: ʻakupa-kupa or ʻokube kube.

Awaous guamensis is the largest ʻoʻopu, reaching a maximum size of 14 inches and inhabiting the middle to lower reaches of the stream. The Hawaiians called it nākea (nōkea in Hilo on the island of Hawai‘i).

The shrimp, Atyoida bisulcata, which the Hawaiians call ʻōpae-kala-ʻole, ʻōpae kolo, or ʻōpae kuahiwi, reaches 2 inches in length and inhabits the upper reaches of the stream in fast water. The prawn, Macrobrachium grandimanus, or ʻōpae 'oea'a, reaches 3 inches in length and inhabits the estuaries and lower reaches of the stream.

Ka i'a hā'awe i ka pa'akai.
The fish that carries salt on its back.

The mountain shrimp (ʻōpae kolo), a creature that does not die readily after being removed from the water. Once a stranger arrived at the house of a man noted for his stinginess. While the host loudly deplored his lack of any kind of meat to eat with the poi, a shrimp with a lump of salt on its back crawled out of a container in the corner. The selfish man had placed it there earlier, with the salt for seasoning, intending to eat it himself.

The mollusk, Neritina granosa, which the Hawaiians call bibīwai or wi, reaches a diameter of 2 inches and inhabits the lower, middle, and upper reaches of the stream. Neritina vespertina, which the Hawaiians call hapawai, reaches a diameter of 1 inch and inhabits the estuary and lower reaches of the stream.
Ka i’a huli wale i ka pohaku.
*The fish that turns over the stones.*

The *wi*, a shellfish found in mountain streams. They can be discovered only by turning over the stones to which they cling.19

**Summary and Conclusions**

Although surrounded and infiltrated by salt water, the geological characteristics of the Hawaiian Islands and their abundant rains have created large underground reservoirs of freshwater lens in the porous basalt, floating on and pressing into the underlying salt water. These underground freshwater sources reside in deep basal aquifers, perch on caprock, and are even diked in the mountains in columns hundreds of feet high.

Hawai‘i’s streams, particularly those on the windward sides of the islands, are typically steep, short, and flashy, suddenly rising to ten times or more of their base flows in heavy rains. In many areas, underground water provides the base flow of streams through springs, seeps, and erosion into underlying aquifers. In times of little precipitation for prolonged periods, these streams may barely flow or become interrupted into isolated pools if their underground sources are disrupted through withdrawals that lower the sources’ water tables below their contributory points to the streams.

The remoteness of the Hawaiian Islands has led to ancient recruitment of only nine freshwater fish, crustaceans, and mollusks, all with life cycles that require a period in the ocean soon after hatching in their normal freshwater habitats. Eight of these nine species have differentiated into species that are found nowhere else in the world. Little is known about the contribution of diminished base flows on the vitality of these stream animals, as so many other factors have contributed to the degradation of stream ecosystems in the Hawaiian Islands. However, because of the life cycle of these stream animals —whose juveniles will return from the ocean to any stream, not just the ones from which they came—restoration of degraded streams could lead relatively quickly to a return of their depleted aquatic life.

These native freshwater fish, crustaceans, and mollusks were important sources of food. Hawaiians were quite familiar with the habitats and life cycles of these nine native species, which were woven into the stories and chants that so pervaded Hawaiian society, as we shall see in the next chapter.
As we have seen from the previous chapter, the mythological history of the Hawaiian Islands and their inhabitants, the kanaka maoli, paints a rich portrait of the highly structured society that developed. “Through the picture given in these recitals the background of old Hawaiian culture may be actually realized. It is that of a people divided into strict classes as chiefs, priests, commoners, and slaves, holding prerogatives according to inherited rank down to their minutest subdivisions, and of land similar[ly] divided, parcelled out by each district chief to his followers during his own lifetime and returned to his successor for redistribution after his death.”

Land Divisions

Except where otherwise attributed, this section and the next are excerpted from Handy and Handy. For a slightly different description of the land divisions, see Malo. For example, Malo uses apana (āpana) as well as moku-o-loko (moku o loko) for the next division down from the island, or moku. In the discussion below, ‘okana as well as moku o loko is used. According to Handy and Handy, apana seems to be of relatively recent origin, and the Hawaiian dictionary defines it as meaning several things: district, section, or parcel. Also, in the adoption of the land division system throughout the Islands, names describing the same level of division may have changed and become specific to a particular island, leading to some confusion. For example, moku, most often used to denote an entire island, sometimes has been used to describe the next largest land division—the district or ‘okana.

Umi-a-Liloa, who defeated all the other chiefs and thus was the first mōʻi of the island of Hawaiʻi, is credited with establishing the land division system that was eventually adopted throughout the islands. Umi also established the system of social classes, with each assigned its own tasks: the papa aliʻi (chiefs), koa (warriors), poʻe pale ʻike (various classes of skilled artisans), and poʻe akamai o ka ʻāina (those skilled in the affairs of the land).

Each moku, or island, was divided into ‘okana (ʻoki, “to cut,” with the suffix ana), or large districts. (For example, on the island of Hawaiʻi, there were
only three ‘okana: Kona, Kohala, and Hāmākua.) ‘Okana were subdivided into abupua‘a, typically extending from the seashore to the mountain. Abupua‘a were divided into strips called ‘ili. Strips of arable land within an ‘ili were mo‘o (“strips”) or mo‘o ‘āina. Pauku (“piece cut off”) ‘āina were pieces of a mo‘o where wetland taro was grown. The lo‘i was a single wetland taro patch. Kībāpāi was land other than lo‘i within an ‘ili that the ‘ohana (extended families) living within the abupua‘a cultivated for their own use.

Within each ‘ili, land was also set aside for the ali‘i of the ‘okana or abupua‘a and for the konohiki, the ali‘i’s supervisor of the abupua‘a. Kō‘ele was the land for the ali‘i and hakuone was the land for the konohiki. The tenant families were responsible for cultivating and harvesting the kō‘ele and hakuone for the ali‘i and konohiki.

‘Okana were also sometimes referred to as moku o loko (loko, “interior”). When the o loko was dropped and only moku used in place of ‘okana, some confusion has resulted between references to islands versus districts. For example, Hutchins states that “the ‘moku’ was a geographical division of an island. For purposes of land tenure, the moku was further subdivided into ‘ahupuaas’ and ‘ilis’.”

A kalana (kala, “to release,” with the suffix na) was a large piece of an ‘okana, which may originally have been part of the ‘okana but subsequently given to ali‘i of first rank.

Umi’s son, Keawe-nui-a-Umi, is thought to have started the custom of redistributing land. Thus, the ali‘i of the ‘okana and abupua‘a and the konohiki might be replaced when a new ruler came into power or when they fell into disfavor. But the common people—the maka‘āinana—usually had the right to stay on the land under cultivation by their ‘ohana.

The term abupua‘a arose out of the fact that the seaward boundary of each such district was marked by an altar (abu) on which a sculptured wooden head of a pig (pua‘a) was placed at the time of the collecting of harvest offerings for the rain god and tribute for his earthly representative, the mō‘i, during the Makahiki festival. The title to an abupua‘a was not hereditary; these subdivisions were allocated and reallocated to loyal supporters by the chief of the moku at the time of his accession. Proprietorship of an abupua‘a gave the right to collect taxes from that area. Actually, from the point of view of the maka‘āinana on the land, the system was one of share cropping rather than taxation, and this sharing between chief and tenant was comprehensive and reciprocal in benefits. It also assured subsistence shares in food, fish, firewood, house timbers, thatch, and the like, to the lesser landholder—the planter.
The size and shape of *ahupua’a* were not uniform; rather, “they varied in size from less than 1,000 to 10,000 acres or more; some extended from the seashore into but not through the timber belt and were cut off by other *ahupua’a* from the main forest areas; some had no contact with the ocean; and others, though extending to the ocean, had only limited sea privileges and were excluded from the main fisheries by the extension of larger *ahupua’a* around them in the sea.”

In contrast to the ‘ili ‘aina, which were part of an *ahupua’a*, ‘ili ku pono (“strips standing in their own right”) were independent of the *ahupua’a* and generally paid no tribute to the *ahupua’a*’s ali‘i, but they did pay tribute to the king, to whom the ‘ili ku pono’s konohiki was directly subservient. An ‘ili ku pono could be within an *ahupua’a* or could be independent of an *ahupua’a*, as was downtown Honolulu, for example, under the chief Kou. ‘Ili ku pono were the closest thing to private property that existed prior to the Great Mahele (discussed later).

An ‘ili could be contiguous—‘ili pa‘a—or in separate pieces—‘ili lele (lele, “jump”)—such as ‘ili that had parcels near the sea and also in the uplands. An example of an ‘ili lele was the ‘ili of Kewalo, with taro lo‘i in Pauoa Valley (behind Punchbowl), kula lands on the seaward (makai) slope of Punchbowl and the plains below, and a coastal strip adjoining Waikiki.

Geographical terms that have relevance to the land divisions include *kaba, kula, kabawai*, and *wao*. The *ko kaba kai* (“the place by the sea”) were areas facing the shore and not suitable for cultivation. Plants that grew there had their uses, such as extracting juice from the leaves of the ‘auhuhu to stun fish.

Above the *kaba* were the *kula* or sloping lands—*ko kula kai*, toward the sea and *ko kula uka*, toward the uplands. The *kula* lands held pili grass for thatching houses, medicinal herbs, and—typically—red soil in which sweet potatoes grew well.

Above the *kula* lands was the *kabawai*, “place (with) fresh water,” with its abundant streams and rich humus washed down from the upland forest. “Here he could find (or make) level plots for taro terraces, diverting stream water by means of ‘auwai (ditches) into the lo‘i, or descending series of lo‘i, until from below the whole of the visible valley afforded a scene of lush green cultivation amidst fresh water glinting in the sun.”

Again, of course, there were exceptions to these general rules. For example, there could be extensive taro lo‘i near the mouths of rivers and streams, as in Hanalei Valley on Kaua‘i and Waipi‘o Valley on Hawai‘i. Furthermore, Handy and Handy’s implication that most of the wetland taro lo‘i were above the *kula* lands is subject to dispute. Hutchins, for example, describes the upland taro as being mostly dryland crops.
The probable area in taro necessary to supply the large early native population is considered to have covered many thousands of acres, of which the nonirrigated upland plantings were probably as important as those on the irrigated lowlands. However, the native Hawaiian population has now dwindled to a small fraction of its former size and the area in taro has likewise greatly decreased. The area reported for the period July 1937 to June 1938 was 79 acres in upland taro and 1,154 in irrigated or ‘wetland’ taro, being stated to have been during that year the most important truck crop grown in the Territory from the standpoints both of cash value and of number of pounds produced [citations omitted].

Finally, there was the *wao* (wilderness), reaching up to the high elevations. “The *wao* . . . provided man with the hard wood of the *koa* for spears, utensils, and logs for boat hulls; pandanus leaves (*lau hala*) for thatch and mats; bark of the *mamaki* [māmaki] tree for making *tapa* cloth; candlenuts (*kukui*) for oil and lights; wild yams and fruits for famine time; sandalwood, prized when shaved or ground as a sweet scent for bedding and stored garments.”

**Water**

Fresh water was the Hawaiians’ most precious resource. As a consequence, it infused their mythology and was the basis for both their material and symbolic concepts of wealth.

Fresh water as a life-giver was not to the Hawaiians merely a physical element; it had a spiritual connotation. In prayers of thanks and invocations used in offering fruits of the land, and in prayers chanted when planting, and in prayers for rain, the ‘Water of Life of Kane’ is referred to over and over again. Kane—the word means ‘male’ and ‘husband’—was the embodiment of male procreative energy in fresh water, flowing on or under the earth in springs, in streams and rivers, and falling as rain (and also as sunshine), which gives life to plants.

Emerson transcribed the following verse, entitled “The Water of Kane”:  

A query, a question,  
I put to you:  
Where is the water of Kane?  
At the eastern gate  
Where the sun comes in at Haehae;  
There is the water of Kane.
A question I ask of you:
Where is the water of Kāne?
Out there with the floating sun,
Where cloud-forms rest on ocean's breast,
Uplifting their forms at Nihoa,
This side the base of Lehua;
There is the water of Kāne.

One question I put to you:
Where is the water of Kāne?
Yonder on mountain peak,
On the ridges steep,
In the valleys deep,
Where the rivers sweep;
There is the water of Kāne.

This question I ask of you:
Where, pray, is the water of Kāne?
Yonder, at sea, on the ocean,
In the driving rain,
In the heavenly bow,
In the piled-up mist-wraith,
In the blood-red rainfall,
In the ghost-pale cloud-form;
There is the water of Kāne.

One question I put to you:
Where, where is the water of Kāne?
Up on high is the water of Kāne,
In the heavenly blue,
In the black-piled cloud,
In the black-black cloud,
In the black-mottled sacred cloud of the gods;
There is the water of Kāne.

One question I ask of you:
Where flows the water of Kāne?
Deep in the ground, in the gushing spring,
In the ducts of Kāne and Loa,
A well-spring of water, to quaff,
A water of magic power—
The water of Life!
Life! O give us this life! [Macrons added.]
The Hawaiian explanation for the origin of springs was that fresh water—\( \text{`\text{\text{'}}\text{\text{\text{\text{\text{'}}}}} \) was female and would gush out when Kāne, the male procreative force, thrust his spear into the ground.

Kāne and Kanaloa are said to have come to Hawai'i from Tahiti . . . [and were] addicted to `\text{\text{\text{'}}\text{\text{\text{\text{\text{'}}}}}' drinking. They traveled about the islands and sometimes stopped to brew their `\text{\text{\text{'}}\text{\text{\text{\text{\text{'}}}}}' at places where there was no water, hence the need to open springs. They first came to Kaua'i, then to O'ahu, then to Kohala on Hawai'i, where they lived in the beima named Mo'okini. From Kohala they went to Hāmakua, and on to Hilo. Near there, at the cliff named Ka'awalii (The small `\text{\text{\text{'}}\text{\text{\text{\text{\text{'}}}}}') they prepared to brew `\text{\text{\text{'}}\text{\text{\text{\text{\text{'}}}}}' and found there was no water. Kāne thrust his spear into the ground, and water came forth. This spring, which continued to flow, was called “The-Water-of-Kāne-and-Kanaloa.” Again at Ka Lae (South Point) in Ka'u they needed water for their `\text{\text{\text{'}}\text{\text{\text{\text{\text{'}}}}}', and Kāne thrust his spear into a rock, where water flowed out. This spring, continuing to flow, likewise was called “The-Water-of-Kāne-and-Kanaloa,” although today it is no longer there. They went to Maui, and there at Hāmakua needing water for their `\text{\text{\text{'}}\text{\text{\text{\text{\text{'}}}}}', they again opened a spring. This spring, which also continued to flow, was called “Kanaloa’s Water.” . . . Others on O'ahu attributed to Kāne and Kanaloa were at Koko Hean, in Waikāne Valley, and at Wai'alae.¹⁴

James Macrae, a Scottish botanist on the British frigate Blonde that brought back the bodies of Liholiho (King Kamehameha II) and Kamāmalu from London in 1825, described one such spring of enormous size.

Pearl River is about seven miles west of Honarura [Honolulu], and is improperly called a river, being rather inlets from the sea, branching off in different directions. There are three chief branches, named by the surveyors, the East, Middle and West Lochs . . . On the path we had left near the Pearl River, we saw several thickly inhabited huts, situated on the side of a ravine stocked with bananas, taro and healthy breadfruit trees just forming their fruit. Here we met with an old Englishman, who told us there was on the opposite side of the ravine a large river coming out under the ground. We went to the place and found that what he had told us was correct, and stood admiring the subterranean stream of fine, cool water. Its source was rapid, forming a cascade nearly 20 feet in height, having ferns and mosses on its sides.¹⁵

In areas where water was scarce, Hawaiians developed ingenious methods of collecting water. At South Point in Ka‘u on Hawai‘i, for example,
water for drinking and for watering small patches of sweet potato near houses was collected in big gourds placed in caves where water dripped from the ceiling. This is a region where there is little rain, but there is much dewfall at night in the warm, wet air from the sea whose moisture condenses in early morning hours upon ground cooled by the flow of cold air down the vast slopes of Mauna-loa.

Another "waterless land" in Kona lay in the area called Kekaha. Hawaiians living there obtained their drinking water from caves, which were numerous thereabouts. To catch water dripping from the ceiling the people made troughs of 'ohi'a, koa, and kukui wood, dubbing them out to a depth of from three to six feet, as though for a canoe hull. Gourd containers and wooden calabashes (bowls) were also used to catch drops from the ceiling of the cave. The interior of these caves was dark, so the Hawaiians used torches made of kukui nuts when collecting their water vessels. As troughs and other containers filled, water was dipped out slowly with a small coconut shell cup and poured into a gourd water bottle, using for a funnel the neck of another bottle gourd, cut off, or a ti leaf folded back on itself. The water was dipped carefully so as not to put sediment into the water bottle. These caves were sacred to Kane, and each was believed to have its guardian spirit.

At Punalu'u in Ka'u on Hawai'i men dived in the bay at some distance from the shore for their fresh water, taking down water bottles, stoppered with a finger. When they reached the chill fresh water welling up from a spring at the bottom of the bay, they removed the stoppers so that the water bottles filled. Punalu'u means "diving spring." There are many other places where drinking water was obtained in this way.

The missionary William Ellis drank some of this water on his survey of the island of Hawai'i for potential missionary stations. "In the evening, we were so favoured as to procure a calabash-full of fresh water from the caves in the mountains, where it had filtered through the strata of lava, and was received into vessels placed there for that purpose. It tasted bitter, from standing long in the calabashes; but yet it was a luxury, for our thirst was great." On the present-day town of Kailua-Kona, Ellis wrote, "Kairua, though healthy and prosperous, is destitute of fresh water, except what is found in pools, or small streams, in the mountains, four or five miles from the shore. The late king Tamehameha used frequently to beg a cask of water from captains of vessels touching at Kairua; and it is one of the most acceptable presents a captain going to this station could make, either to the chiefs or missionaries."
A reliable source of fresh water was essential to the taro plant, the older brother of the Hawaiians and their staple food. And wetland taro, not the dryland crops, held the position of eminence. For example, Fornander named only a few types of dryland taro but numerous wetland varieties, as follows:

1. Dryland varieties: ‘elepaio, ‘apuwai-pi’i-ali’i, lehua-kū-i-ka-wao, kūmū, manini, and ‘ape; versus

An early visitor, Prussian botanist Meyen in 1831, was impressed by the great expanses of taro patches (lo‘i) and the prodigious appetites of the natives for this staple food.

We had scarcely left the gardens of the city houses—which are for the most part planted with beautiful flowers—when we came upon expansive plantations of Arum macrorrhizos [sic]. These are known here by the name of taro [taro] fields. What a sight for us to see such great fields of this precious food-plant! Taro is planted in water, for which purpose they have dug huge square fields to a depth of 2 to 3 feet and filled them with water. The borders of these basins, which divide the property of various owners, are also—at least in densely cultivated areas—used as foot-paths and are densely planted with banana trees. Near the water and in this fertile ground they attain a giant size. Right next to these fields lie fields planted with sugar cane, which is used here only for food [but by the end of the century, sugarcane would become the dominant commercial crop in Hawai‘i and change forever the use of the state’s freshwater resources]. The bluish green of the sugar cane is a remarkably beautiful contrast to the light green of the young banana leaves and the velvety color of the taro leaves. . . .

The fields of taro, which are planted under water, extend in this [Nu‘uanu] valley to an elevation of 800 feet and give it a very interesting appearance when seen from above. These fields are generally square pieces of land, 40 to 50 feet wide and just as long. Since it is a sloping valley they are laid out in terraces so that, as has already been mentioned, the water
from one basin can drain down into the next when it has attained the necessary height in the former. The leaves of this precious plant rise only slightly above the basin and the individual tubers are planted farther apart than our potatoes—somewhat like cabbages—but also in straight rows.

At an elevation of 800 feet the cultivation of the so-called dry taro begins. This plant is the same *Arum macrorrhizum* [sic] which is planted down in the plains under water. It is also planted in very good soil but the tuber attains neither the size nor the good taste of the variety which is cultivated in the water. It is not used for the preparation of poi, the favorite dish of the Sandwich Islanders.

The preparation of taro, the basic food of the inhabitants of the Sandwich Islands, is extraordinarily diverse. The roots are generally between the size of two fists and the size of a child’s head. They are baked in the earth and then eaten with or without salt, like bread. The tubers are also cut into slices and fried in fat, or, what is most common, they are boiled, then kneaded in large wooden troughs—which we saw up to 10 feet long and 3½ feet wide—by beating them with large stones and adding a bit of water. Dry taro is prepared and eaten this way. To the mashed pulp of the wet taro they add more water and leave the mass to ferment, which ordinarily takes place in only 24 hours. This semi-fluid pulp, called *poi*, is the favorite food of the Sandwich Islanders and the enormous quantities that they can consume are often unbelievable. Since the use of spoons has not yet been introduced into this land, the Indians must eat this pulp with their fingers, which looks somewhat shocking [original footnote omitted].

The word for fresh water—*wai*—also found its way into the most fundamental precepts of Hawaiian society.

Water, which gave life to food plants as well as to all vegetation, symbolized bounty for the Hawaiian gardener for it irrigated his staff of life—taro. Therefore, the word for water reduplicated meant wealth in general, for a land or a people that had abundant water was wealthy.

The word *waiwai* means wealth, prosperity, ownership, possession. Literally it is “water-water.” A Hawaiian farmer who had all the water he needed for growing taro was indeed a prosperous man.

The word *kānāwai*, or law, also tied back to water. *Ka-na-wai* is literally “belonging-to-the-waters.” With farms along the water system upon which all depended, a farmer took as much as he required and then closed the inlet so that the next farmer could get his share of water—and so it went until all had the water they needed. This became a fixed thing, the
taking of one's share and looking after his neighbor's rights as well, without greed or selfishness.

So a person's right to enjoy his privileges, and conceding the same right to his fellow man, gave the Hawaiians their word for law, kānāwai, or the equal sharing of water.²¹

The Great Mahele

According to Handy and Handy, “The fundamental conception of property and law was . . . based upon water rights rather than land use and possession. Actually there was no conception of ownership of water and land, but only of the use of water and land” (emphasis added).²²

These fundamental concepts were about to change in the mid-nineteenth century, with the implementation of the Great Mahele, the division of land between the king and the ali'i and konobiki and the kuleana awards to the hoa‘aina tenants of the ahupua'a that followed.²³ There was to be ownership of land and recognition of “a right to such quantity of water as was customarily used on the land at and immediately before the date of the grant so long as that quantity continued to be available.”²⁴ The Kingdom of Hawai'i—later to become the Territory of Hawai'i after the overthrow of the monarchy in 1893 and finally the State of Hawai'i in 1959—was about to embark on the journey that was to define Hawai'i's blending of precontact practices with Western concepts of property and water law.

Kauikaouli became King Kamehameha III upon the death of his brother Liholiho, King Kamehameha II, on a visit to England in 1824. King Kamehameha III came under pressure from foreigners used to owning land in fee simple title in their homelands, and he had “an anxious desire to free his lands from the burden of being considered public domain, and as such, subjected to the danger of confiscation in the event of his islands being seized by any foreign power, and also his wish to enjoy complete control over his property.”²⁵

The series of events leading to the establishment of private property rights in Hawai'i began in 1839 with a Declaration of Rights:

The bill of rights issued in 1839, and included with some amendments as a preamble in the first constitution of 1840, declared among other things, that the chiefs and the people were entitled to the same protection under the same law; that all persons should be secured protection in their lands, building lots, and all property; and that nothing should be taken from any individual except by express provision of law. . . .
[In the constitution] is the declaration that to Kamehameha I, the founder, had belonged all the land, but not as his own private property; that the land belonged in common to the chiefs and people, of whom the king was the head, and that it was subject to his management ["the land was not his own property. It belonged to the chiefs and people in common, of whom Kamehameha I was the head, and had management of the landed property"]]. This appears to have been the first formal acknowledgment by the government that the common people had some form of ownership interest in the land as distinguished from rights of use [footnotes omitted].

In December 1845 a statute creating the Board of Commissioners to Quiet Land Titles (commonly referred to later as simply the Land Commission) was enacted—and reenacted again the following year, in April 1846, as part of the creation of the Kingdom’s executive departments.

The statute had provisions for claims by foreigners as well as natives. But in the Land Commission’s August 1846 “Principles Adopted by the Board of Commissioners to Quiet Land Titles in Their Adjudication of Claims Presented to Them” (enacted into law two months later by the legislature in October 1846), the Land Commission concluded that foreigners could not acquire title to land under existing law, and therefore “there are but three classes of persons having vested rights in the land—1st, the government, 2nd, the landlord, and 3rd, the tenant.”

These three classes held undivided interests in the land, however, so what was needed to enable individuals to gain clear titles to the land? The answer was the Great Mahele.

Between January and March 1848, the king and 245 konobiki reached agreement on the division of their lands (in the Mahele, konobiki meant the ali‘i who had been granted the land by the king, not their agents who actually managed the lands for them). Each konobiki reached agreement with the king on the division (mabele) of his land and recorded it in a book called the “Mahele book,” with the lands to be kept by the king on one side and those to be given to the konobiki on the other. This was in effect a “quitclaim” procedure between two parties in which each agreed what portion of the land belonged to him and what portion belonged to the other.

The day after the mabele between the king and konobiki were concluded, the king further divided his lands between his own private lands—the “Crown lands”—and “government lands,” and this division was also recorded in the Mahele book.
For the konobiki, the next step was to file their claims and then make their cases before the Land Commission, which determined their existing rights in the land at the time of the December 1845 act. If the claim was confirmed and an award was made by the Land Commission, title to the land was obtained through the issuance of a royal patent, subject to payment.\(^3\)

In exchange for the land, the konobiki were supposed to make a payment to the government of one-third of the unimproved value of their land awards, or of one-third of the land. (But see the later discussion relating that the konobiki were given royal patents—-and hence, fee simple title—even if they didn’t make the required payment; and it was not until 1909 that a law was passed requiring them to make the payment under penalty of forfeiture of their lands to the government). The king, in conveying a larger portion of the land to the government than he retained for himself, dispensed with any question that he might also have to pay for the land he retained. As the Hawai‘i Supreme Court would conclude in an 1877 decision, “No one would seriously contend that the King was obliged to go to the Land Commission for awards or patents of his own lands, even for commutation purposes, when we bear in mind that he had surrendered to the government by far the greater portion of the lands that remained his, which extinguished completely the government right to commutation in what was left.”\(^3\)

The konobiki, Crown, and government lands were all subject to the rights of their tenants, who also had to file for title with the Land Commission. In November 1846, a law had been passed giving a native tenant the right to buy the land he had cultivated, but—as with the makele between the king and his konobiki—some process had to be worked out to accomplish this. Finally, in August 1850, another law was enacted, setting up the process by which the tenants could obtain fee simple titles in the lands they cultivated.

Among this statute's provisions were the following: (1) They were entitled to any portion of lands they actually occupy and improve; (2) “they shall only be entitled to what they have really cultivated, and which lie in the form of cultivated lands; and not such as the people may have cultivated in different spots, with the seeming intention of enlarging their lots; nor shall they be entitled to waste lands”; (3) tenants on government lands need not pay, and tenants on the king’s or konobiki’s lands also need not pay, because payment for the land had in effect already been made by the king and konobiki; and (4) government lands should be set aside in 1- to 50-acre lots, for sale to natives who did not have sufficient land.\(^4\)

Regarding commutation, Kuykendall notes that “the theory was afterwards developed that the commutation of a kuleana was included in the com-
mutation of the larger division (ahupua'a or ‘ili) within which it was situated; but this idea does not seem to have been suggested in the course of the contemporary discussion in 1849 and 1850.”33 (Section 7 of the August 1850 act also defined the gathering rights of native tenants, thereby superseding prior laws and customs, and was in turn itself superseded by an amendment to the act in 1851. These provisions, because they are important in their own right, will be discussed separately.)

Finally, as already noted, an October 1846 statute had prohibited foreigners from acquiring title to land, limiting landowners to the government, the landlord, and the tenant. However, by a series of laws passed in 1850 and 1854, foreigners were granted the right to buy and sell land.34

At this point, it would be instructive to review the sequence of laws enacted to allow fee simple property rights for the first time in the Hawaiian Islands.

The Land Commission was created in December 1845 and was to have been terminated by February 14, 1848. Between January 27 and March 7, 1848, the king and konohiki concluded their Mahele; and on the next day, March 8, 1848, the king divided his lands between Crown and government lands. In November 1846, tenants had been given the right to buy the land they cultivated, but it was not until August 1850 that the process for doing so was enacted into law. Therefore, the original statute creating the Land Commission expired before the Mahele and subsequent mahele between Crown and government lands were completed. Tenants were given the right to own land only fifteen months before the Land Commission was to expire, and the process to acquire those rights was enacted into law two and one-half years after the Land Commission was to have expired.

Several statutes extended the life of the Land Commission to March 31, 1855, in order to complete its work. Parties had until December 30, 1854, to present their evidence. But these statutes extended the life of the Land Commission only in order to complete its work on claims filed up to February 14, 1848 (“[N]othing in this act . . . shall be construed as giving said board any power to receive or act upon any claim . . . presented . . . subsequent to the fourteenth day of February, A.D., 1848”).35

Subsequent laws extended the time for the konohiki to file claims until January 1, 1895, either through the Land Commission, which expired at the end of March 1855, or through the minister of the Interior, as long as the name of the konohiki filing the claim appeared in the 1848 Mahele book. These claims were subject to payment of one-third of the unimproved value of the land at the date of the Mahele, and if the government had conveyed the land to someone else in the interim, that party would prevail over the late-
filing konobiki. However, none of these extensions applied to the kuleana claims, which had to be filed by February 14, 1848, the original termination date of the Land Commission.

A patently unsympathetic Hawai‘i Supreme Court had this comment in 1895:

If the Land Commission expired and the boa‘aina or native tenants neglected to present their claims for the parcels of the land which they desired, and for which they would ordinarily be awarded a kuleana title, showing merely their occupation of the same as a foundation for it, we think they must be considered as content with their prior status as tenants by permission of the land owner. . . . The legislation in behalf of the native tenants was extremely liberal. . . . The law did not intend to . . . favor those who slept upon their rights. 

But surely the Supreme Court was not so naïve as to believe its own rhetoric. Years before the court uttered these absurd sentiments, a commentator in the newspaper, the Polynesian, had this to say:

This requirement that, in a society so little used to fee simple tenure of land, claimants must present their claims to a commission, was at the bottom of much of the miscarriage of justice. The commission should have gone in the field to investigate who were in fact the occupants of kuleanas, not claimants, and heard their claims in the open. This mistaken policy resulted in many natives not submitting claims, because of lack of knowledge as to how to proceed [italics in original].

The Land Commission's timetable for filing claims was from February 11, 1846 (when notice for filing claims was first published), to February 14, 1848. But it was not until November 1846 that native tenants were given the right to purchase their kuleana, and it was not until August 1850 that a process for doing so was enacted into law. Furthermore, the Mahele between the king and konobiki and the division of the king's lands between Crown and government lands (January–March 1848) were not completed until after the filing period was over. Therefore, the native tenants (1) had at most fifteen months to file their claims (and in reality much less time, since the fifteen months were from the date of the law's enactment in November 1846 to February 1848); (2) would have had to file their claims with the Land Commission before the Mahele between the king and konobiki and the following mabele between Crown and government lands had been completed; and (3)
did not have guidance on how to proceed with their claims until two-and-a-half years after the filing deadline.

In stark contrast to how the native tenants were treated, laws were enacted three times to keep extending the time for konobiki to file for their land claims, and they were able to do so forty-seven years past the nonextended deadline for the boa'aina native tenants.

The resulting division between the king, government, konobiki, and common people was approximately as follows: (1) to the king, about 1 million acres; (2) to the government, about 1.5 million acres; 3) to the konobiki, about 1.5 million acres; and (4) kuleana awarded to native tenants, about thirty thousand acres. 39

Kuykendall made the following important distinction: “It must be remembered, however, that nearly all of the kuleanas were lands very valuable for native agriculture as long as the appurtenant water rights were assured to them, while extensive areas of crown, government, and chiefs’ lands were useless mountain wastes or lava strewn deserts or were covered with forests which benefited all by conserving the water supply.” 40

The Land Commission had also initially proposed that the lands be divided in thirds: one-third to the king, one-third to the konobiki, and one-third to the native tenants. But it was not a practical solution, given the great variety of land—much of it in vast stretches of wao (wilderness)—and their various uses or nonuses. Thus, this viewpoint was transformed in the November 1846 law giving the tenants the right to purchase their cultivated land and house plots into the following: (1) The land had to be divided between the king and his konobiki; (2) the government’s share should be one-third of all lands (and thus the king’s portion was further divided between lands to be in his personal possession and the remainder in the hands of the government); and (3) the rights of the native tenants should be preserved in these initial divisions. 41

While Kuykendall is right in his assessment of the much greater per-acre value of the kuleana lands versus those of the king, government, and konobiki, it is clear that much more of the kuleana lands could have been awarded. Kuykendall’s own analysis of the August 1850 law that established the process by which the native tenants would obtain fee simple title in their kuleana concluded that it was done to protect the tenants’ rights as land began to be sold after the 1848 Mahele and the question of how to protect the tenants’ rights became urgent. Yet curiously, he relegated the following comment to a mere footnote: “Claims for these parcels of land had of course been presented to the land commission not later than Feb. 14, 1848, the last date for filing claims,” 42 and this date had passed during the midst of the division of lands.
under the Great Mahele. This was not merely a procedural issue, as Kuykendall himself concluded that the common people were probably not paying much attention to the land division issue being so greatly debated at the governmental level.

But it is probable that a large majority of the common people were not greatly concerned about the matter. A few of them had obtained fee simple titles by purchase or otherwise, and a way was open for others to convert their present holdings into fee simple estates, but it must have been, from the tenants' point of view, an expensive and difficult process... and many—perhaps most of them—would doubtless have been content to let things go on as they were, rather than risk the unknown perils of the new and unfamiliar system.43

Native tenants fortunate enough to have filed claims with the Land Commission before the February 14, 1848, deadline were required to survey the kuleana lands for which they were applying, at their own expense. As a result, only 13,514 kuleana claims were filed with the Land Commission, of which only 9,337 were awarded. Of the unawarded claims, about fifteen hundred were duplicates and about fifteen hundred were rejected as deficient. Of the approximately one thousand remaining unawarded claims, either they were not brought forth before the Land Commission after the initial claim was filed, they were relinquished to the konohiki by the claimants, or the claimants had died without leaving legal representatives.44 (As there were kuleana lands not only on the konohiki lands but also on Crown and government lands, lands not claimed on the latter lands remained with the king or the government.)

The konohiki, on the other hand, received title to their lands without surveys and only by the names of the abupua‘a and ‘ili on the rationale that it was impracticable to survey so many large and varied abupua‘a and ‘ili in the time allotted. While the konohiki were in effect given forty-nine years to file and be granted title, the initial period was only two years, from February 11, 1846, to February 14, 1848. After the initial two-year period, extensions were granted in steps of one year (1854–1855), two years (1860–1862), and two years (1892 to the beginning of 1895).45

A Boundary Commission was created in 1862 under which holders of title by name only were required to apply to determine their boundaries. After creation of the Boundary Commission, no further patents would be issued by the government in confirmation of an award of title by the Land Commission or its successor, the minister of Interior, until the Boundary Commission had determined the boundaries of the land at issue. The patent was official recog-
nition that the required payment had been made to the government of either one-third of the value of the unimproved land at the time of the Mahele or of one-third of the acreage.46

But for more than sixty years, the required payments were not enforced on the konobiki. Only in 1909 was a law passed that threatened the konobiki and their successors in title with foreclosure if payments were not made.47 Lands with title granted only by names and even patented for payment were at some peril of being superceded in title by lands with title granted by survey and with patents paid, but these were not common. For example, one case in which title granted by survey and patented triumphed over a title granted by name only and patented occurred when patents had been issued for two adjoining lands granted title by name only. But one owner subsequently applied to the Boundary Commission for a determination of his boundaries, received it, then applied for a new patent and also received it, and his new title included some of the lands of the owner who continued to hold title by name only. The Hawai‘i Supreme Court awarded title to the owner who had his property surveyed.48

Finally, what happened to konobiki lands that remained unawarded and to kuleana lands that were later forfeited, such as by lack of an inheritor?

The last act extending the time for konobiki to file for land claims, passed in 1892 and expiring in 1895 (L. 1892, at 68), stated that “any person having claims under this act who shall fail to present the same before said date shall be forever barred and his rights under this act shall revert to the government.”49 (Recall that payment of either one-third of the value of the unimproved land at the time of the Mahele or payment of one-third of the land had to be made to the government in exchange for title.)

For kuleana whose owners died without heirs, the land reverted to the owners of the abupua‘a or ʻili from which the kuleana had been carved out—that is, to the konobiki, the king, or the government. (After the overthrow of the Hawaiian Kingdom in 1893, the king’s Crown lands became part of the government lands.)

**Summary and Conclusions**

Over the centuries, a sophisticated land division system of shared uses and responsibilities evolved in the Hawaiian Islands among the king, his ali‘i and their konobiki, and the makaʻainana.

Water symbolized bountifulness, because it irrigated taro, the Hawaiian staff of life. Taro lo‘i were irrigated by diverting stream water through ʻauwai, or ditches. Water was of such importance to Hawaiian agriculture that stated
twice—waʻiwaʻi—it was the word for “wealth.” The equal sharing of water—
kaʻnawai—also represented the law: a person’s right to enjoy his privileges
and conceding the same right to his fellow man.

The Great Mahele of 1848 initiated the process of converting from a sys-
tem of shared use of water and land to a system of private ownership. (Until
the 1970s, water too could be privately owned. Water law is discussed in chap-
ter 5.) Three classes of persons would have vested rights in the land: the gov-
ernment, the landlord, and the tenant. First, the Mahele divided the land
between the king and his landlords, subject to the rights of their tenants. The
tenants were then to be given title to their kuleana—their house plots and the
land they cultivated for their own use. (Tenants were also given the right to
continue using what had been common lands for traditional and customary
purposes; that is, to gather firewood, house timber, thatch, fish, and so on.
These rights are discussed in the next chapter.)

The landlords were given numerous chances to record and perfect title
to their lands, the deadlines being extended several times until 1895. The ten-
ants, on the other hand, were given no such extensions. The deadline for filing
their kuleana claims remained February 14, 1848, when the Great Mahele was
still taking place between January and March 1848. Tenants who did not meet
the filing deadline were prohibited from proving their claims after the pro-
cess for doing so was finally enacted into law in August 1850. As a result, only
13,514 kuleana claims were filed, of which only 9,337 were awarded.

Thus, private ownership of their kuleana accrued to only a relatively few
makaʻaina. The kuleana of all others remained in the possession of the ahupaʻa’s owners—the king (as his private possession), the government (as pub-
lic land), or the aliʻi and their konohiki. But as we shall discover in the next
chapter, tenants were also given the right to continue using what had been the
ahupaʻa’s common lands for traditional and customary purposes; that is, to
gather firewood, house timber, thatch, fish, and so forth. These rights were to
be retained by tenants whether or not they also owned the land they inhab-
ited in the ahupaʻa. And while the descendants of the original tenants who
continue these traditions and customs today are few in number, their right to
exercise these practices on what became private property would have a major
impact on the state’s land use policies.