EARLY POST-EUROPEAN CONTACT PERIOD

Trade in Agricultural Products and Forest Resources

During the first few decades following the arrival of European ships in Hawai‘i, the people of the Islands continued to practice subsistence agriculture. Beginning with Captain Cook, ship crews bartered with Hawaiians and exchanged iron and manufactured items for foodstuffs, trade that may have been considered gift-giving by the Hawaiians (Morgan 1983). As an increasing number of European and American ships began to visit Hawai‘i to replenish their stores, regular trade in agricultural products began to develop (McEldowney 1979). The earliest ships traded for the staples of Hawaiian agriculture, primarily pigs (Sus scrofa), bananas (Musa x paradisiaca), taro (Colocasia esculenta), and sweet potatoes (Ipomoea batatas) (Menzies 1920; Beaglehole 1967). The number of crops in the Hawaiian Islands increased with the continual introduction of new cultivated plants by crews of sailing vessels and new residents. Nagata (1985) catalogued more than 100 species, primarily food plants, that were introduced in the 60 years after initial European contact. By the 1830s, a great variety of fruits and vegetables was available in Honolulu markets to provision ships (Meyen 1981).

Trade in foodstuffs and materials for caulking and ropes expanded with shipping traffic to the Hawaiian Islands. Fiber from the endemic olona (Touchardia latifolia) produced extremely strong cordage valued by western sailors for ship rigging (Neal 1965). In the first half of the 19th century, the sandalwood trade, North Pacific fur trade, and whaling activities ensured that many ships would require provisioning in the Hawaiian Islands (Kuykendall 1938). Also during this period, crops (particularly sweet potatoes and white potatoes, Solanum tuberosum) began to be grown for export to the western United States (Barrera and Kelly 1974). The California Gold Rush of the 1840s created a demand for agricultural products that was partially met by Hawaiian farms; during this decade more than 80,000 barrels of potatoes were exported to the West Coast of North America each year (Creighton 1978). However, as the Hawaiian population had greatly decreased (Kelly 1983; Stannard 1989) and nonnative people were generally not yet allowed to own land (Kirch 1985a), export crops were probably cultivated on lands formerly used for Hawaiian subsistence and did not represent an expansion of agriculture. This changed after the mid-19th century, when the all i (ruling class) and foreigners began to develop large commercial farms to supply the "external market" such as whalers (Morgan 1983).

Firewood for Whaling Ships. The whaling industry contributed greatly to the early 19th century increase in trade at Hawaiian ports, particularly Lahaina, Hilo, and Honolulu. Whalers hunting right, bowhead, gray, humpback, and sperm whales (Balaena glacialis, B. mysticetus, Eschrichtius robustus, Megaptera novaenangliae, Physeter macrocephalus) in the North Pacific used Hawai‘i as a provisioning stop and as a discharge point for whale oil and bone (Dorsett 1954; Culliney 1988). Whaling ships began to arrive in 1819, and more than 100 sailed to Hawai‘i in each year of the 1820s. In 1822, two English missionaries counted 19 whaling ships in Kealakekua Bay and 24 in port at Honolulu (Culliney 1988). Whaling continued to accelerate, and by the 1840s
the number of ships visiting Hawaiian ports each year exceeded 400 (Kuykendall 1938). For 30 years, whaling was the dominant economic activity of the Hawaiian Islands (Culliney 1988). This activity continued until the late 1860s, when poor whale catches, the introduction of petroleum for use in lamps, and the American Civil War effectively put a stop to the American whaling industry (Dorsett 1954; Kuykendall 1953). The amount of whale oil and bone shipped from the Hawaiian Islands greatly decreased after 1870 and was too insignificant to report after 1875 (Schmitt 1977). A local whaling industry concentrating on humpbacks in waters near Maui began in the 1840s and continued until humpback whales became rare in the late 1860s (Culliney 1988).

Whaling ships required large quantities of firewood to fuel the boilers that rendered whale blubber into oil. Firewood, like other provisions, was supplied in Hawaii and may have had an "appreciable effect in reducing forest areas" (Kuykendall 1938). The trade in firewood to whalers was sustained for almost 50 years and must have resulted in the export of vast quantities of wood. In 1854, for example, 158 cords of wood (more than 20,000 ft³, a volume representing at least several hundred trees) were supplied to ships at just one Hawaiian port, Hilo (Kuykendall 1938). Damage to lowland forests near leeward ports (e.g., Kawaihae, Lahaina) must have been even greater. In some years more than 500 whaling ships would call in the Hawaiian Islands (Kuykendall 1938), and a ship might return with as much as 1,000 barrels of rendered oil (Dorsett 1954). Demand for firewood came also from the populations of the growing port cities. On Kaua‘i, the slopes above Koloa were denuded in the 1840s and 1850s to provide firewood for ships, plantations, and export to Honolulu (Culliney 1988).

Sandalwood Trade. The trade in sandalwood or 'iliahi (Santalum spp.) had a greater impact on the Hawaiian environment than most other enterprises of the early 19th century. Although some sandalwood was collected and exported as early as 1791 (MacCaughey 1918), the period of intensive sandalwood export was relatively short lived, lasting only from 1815 to 1826 (St. John 1947). During this time, vast quantities of the fragrant heartwood were exported from Hawaii to China, where it was used for chests, carved objects, and incense. The estimated amount of sandalwood exported from Hawaii in 1821-22 was 1.8 million kg (4 million lb or 30,000 piculs) (Schmitt 1977). In the following season (1822-23), more than 1.1 million kg (2.5 million lb) of Hawaiian sandalwood were exported to Canton, China (St. John 1947). Bryan (1961a) estimated that more than 6,000 sandalwood trees would be required to fill the hold of one ship.

As a royal monopoly, sandalwood brought great wealth to the kings of Hawaii, amounting to more than $400,000 in one year (Rock 1913). However, the Hawaiian royal family soon became indebted to traders, as they were at the same time paying large sums for western goods (Judd 1927). After the death of Kamehameha I in 1819, the collection of sandalwood accelerated to enable the Hawaiian kings to pay off the debt (St. John 1947). On a visit to the island of Hawaii in 1823, Ellis (1827) reported that hundreds of Hawaiians of Waiakea were engaged in the search for sandalwood in the mountains of O‘ahu and that villages of the Kohala District were nearly deserted for the same reason. Ellis also observed thousands of people engaged in hauling sandalwood logs to be shipped from the port of Kawaihae.

The result of this intense effort to collect sandalwood must have been a significant change in the species composition of the remaining low- and mid-elevation dry and mesic forests. While still of occasional occurrence in the middle of the 20th century,
sandalwood was "decimated" on O'ahu, particularly in the mountains behind Honolulu, and the low-elevation forests in which the tree was most common are now gone (St. John 1947). Contributing to the demise of lowland forest was the use of fire to detect sandalwood by the fragrant smoke produced when the tree burned. Frierson (1973) speculated that the logging and burning in the sandalwood era was a major factor in the destruction of the lower forests of Honolulu, an ahupua'a (land division) on O'ahu that was owned by the royal family. On the island of Hawai'i, sandalwood cutting is likewise thought to have contributed to the loss of forests between Kawaihae and Waimea (Barrera and Kelly 1974).

By 1831, when Meyen (1981) visited O'ahu, the sandalwood trade was greatly reduced due to poor quality and depressed prices. When the U.S. Exploring Expedition under the command of Commodore Charles Wilkes explored the Islands in the 1840s, the scientists reported seeing only small shrubs of sandalwood on O'ahu (St. John 1947). However, several hundred thousand pounds of sandalwood were exported annually between 1836 and 1859, perhaps from islands other than O'ahu. Lesser amounts were shipped to China through 1876 (Schmitt 1977). Although sandalwood of saleable size and quality was eliminated from many lowland forests, particularly near centers of population, large sandalwood trees may still be seen in areas that were remote and less accessible in the 19th century.

**Pulu.** Another export trade detrimental to the Hawaiian forests was that of pulu, the soft reddish "hairs" that clothe the young fronds and stipe bases of Hawaiian tree ferns, particularly the hāpu'u-pulu or Cibotium glaucum. This material was used to stuff pillows and mattresses. Pulu was collected by cutting off fern fronds and scraping the fibers off stipes (Doerr 1932), a process that often required the cutting or pushing over of large tree ferns (Hillebrand 1888). Between 1851 and 1884, several hundred thousand pounds were annually collected from the Kilauea region of Hawai'i Island and shipped to North America (Neal 1965). Fifty to 75 people were employed in pulu collection and drying at the "Pulu Factory" near Napau Crater in what is now Hawalī Volcanoes National Park (Doerr 1932). Pulu was also collected in the Waimea region of Hawai'i until the tree fern had largely disappeared there (Barrera and Kelly 1974). Pulu collection and trading was an important source of income for the people of Kaū in 1860 (Kelly and Crozier 1972). The trade in pulu was flourishing as early as 1831, when Meyen (1981) noted that large quantities were gathered by Hawaiians to sell to foreigners. This enterprise continued and increased for several decades. Between 1860 and 1864, the annual export of pulu amounted to almost 272,000 kg (600,000 lb) (Kuykendall 1938), with more than 335,500 kg (738,000 lb) exported during the peak year of 1862 (Doerr 1932). After 1865, annual exports of pulu decreased, and the industry failed in the 1880s when superior stuffing materials replaced pulu, which had a tendency to mat, absorb moisture, and disintegrate (Doerr 1932; Schmitt 1977). A few decades later, for a brief period around 1920, the starchy cores of Hawaiian tree ferns were used for the commercial production of laundry and cooking starch (Krauss, n.d.).

Removal of the tree fern, a common understory dominant of lowland wet forests, may have seriously altered natural conditions, allowed the invasion of alien plants (Burton 1980), and even resulted in destruction of some native forests in over-exploited areas (Neal 1965). Hillebrand reported that pulu gatherers often "sacrificed the whole tree" to gather the pulu at the top, and in this way cleared away formerly "extensive thickets" of tree fern (Hillebrand 1888).
Wild Cattle, Goats, and Sheep

Cattle (Bos taurus) were first introduced into the Hawaiian Islands in 1793 and 1794 by Captain Vancouver, who landed animals at Kealakekua on the Kona coast of Hawai‘i Island (Tomich 1986). A kapu (taboo) was placed on these animals to allow them to increase, and by 1802 cattle were numerous and destructive to Hawaiian farms of Wai‘a area (Ellis 1827), and in the following decade great numbers of wild cattle were noted on Mauna Kea by explorers such as Mārea (1972) and Douglas (1914).

By the 1820s, John Parker and other resident foreigners had begun to hunt wild cattle in Waimea, first for salted beef to provision ships and later for tallow and hides destined for export (Wellmon 1969). The herds of wild cattle were decreased during the next 20 years as Parker and others began to capture and tame cattle to raise in ranching operations. Even so, wild cattle continued to be a problem on Hawai‘i Island and on O‘ahu, where such animals roamed near Honolulu and were rounded up and driven through the streets as late as 1850 (Kramer 1971).

In 1851, the island of Hawai‘i was estimated to have 12,000 wild cattle and only 8,000 domestic animals (Henke 1929). By the mid-19th century, wild cattle were recognized as destroyers of Hawaiian forests and were blamed for converting the forests of Waimea into open plains, thus reducing moisture and precipitation (Anon. 1856). Wild cattle were still abundant in the ‘ōhi‘a (Metrosideros polymorpha) forests between Waimea and the Hamakua coast and at higher elevations on Mauna Kea when Isabella Bird visited the island in 1873 (Bird 1966). With the development of ranching, wild cattle were significantly reduced, although a large number, perhaps as great as 10,000, remained on Mauna Kea at the turn of the century (Hall 1904). Relatively small numbers of feral cattle, some recently feral from nearby ranches, continue to exist today on Hawai‘i Island on the slopes of Mauna Kea, leeward Mauna Loa, and remote forests of the Puna District.

Goats (Capra hircus) and sheep (Ovis aries) were also introduced into Hawai‘i in the late 18th century by European ship captains and established feral populations soon after their release (Tomich 1986). Like cattle, these ungulates began to impact natural vegetation almost 200 years ago and continue to degrade native systems in many areas. The effects of these and other feral animals are discussed in a subsequent section.