















Section 5: Geography and Environment

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Section 5

GEOGRAPHY AND ENVIRONMENT

This section relates to land and water areas, physical geography, climate, air and water quality, and other geographic and environmental measurements of Hawaii. Most statistics on land use and ownership, however, appear in Section 6.

Important sources of data include the U.S. Geological Survey, the National Ocean Survey, the National Climatic Data Center, the Division of Water Resource Management of the Hawaii State Department of Land and Natural Resources, the Hawaii State Department of Health, and the University of Hawaii Institute of Geophysics. Detailed information is given in *Atlas of Hawaii*, 3rd edition, published by the University of Hawaii Press in 1998. National data are reported in the *Statistical Abstract of the United States: 1999*, Section 6.

Table 5.01-- GREAT CIRCLE DISTANCES BETWEEN SPECIFIED PLACES

Places	Statute miles	Nautical miles	Kilometers
DISTANCES FROM HONOLULU INTERNATIONAL AIRPORT			
Hawaiian Islands locations:			
Hilo, Hawaii	214	186	344
Kailua, Kona, Hawaii	168	146	270
Kahului, Maui	98	85	158
Lanai Airport	72	63	116
Molokai Airport	54	47	87
Lihue, Kauai	103	90	166
Puuwai, Niihau	152	132	245
Nihoa	283	246	455
Necker Island	520	452	837
French Frigate Shoals	556	483	895
Gardner Pinnacles	688	598	1,107
Maro Reef	851	739	1,369
Laysan Island	936	813	1,506
Lisianski Island	1,065	925	1,714
Pearl and Hermes Atoll	1,208	1,050	1,944
Midway Islands	1,309	1,137	2,106
Kure Atoll	1,367	1,188	2,200
Other Pacific locations:			
Apra Harbor, Guam	3,806	3,307	6,124
Auckland, New Zealand	4,393	3,817	7,068
Baker Island	1,900	1,649	3,058
Hong Kong	5,541	4,815	8,915
Howland Island	1,900	1,649	3,058
Jarvis Island	1,560	1,354	2,511
Johnston Atoll	820	713	1,319
Kingman Reef	1,073	932	1,726
Kiritimati (Christmas Island), Kiribati	1,344	1,168	2,163
Majuro, Marshall Islands	2,271	1,973	3,654
Manila, Philippines	5,293	4,599	8,516
Nuku Hiva, Marquesas Islands	2,400	2,086	3,864
Pago Pago, American Samoa	2,606	2,265	4,193
Palmyra Atoll	1,101	957	1,772
Papeete, Tahiti	2,741	2,382	4,410
Suva, Fiji	3,159	2,745	5,083
Sydney (Port Jackson), Australia	5,070	4,406	8,158
Tokyo, Japan	3,847	3,343	6,190
Wake Island	2,294	1,993	3,691

Continued on next page.

Table 5.01-- GREAT CIRCLE DISTANCES BETWEEN SPECIFIED PLACES -- Con.

Places	Statute miles	Nautical miles	Kilometers
DISTANCES FROM HONOLULU INT. AIRPORT--Con.			
North and South American locations:			
Anchorage, Alaska	2,781	2,417	4,475
Cape Horn, Chile	7,457	6,480	11,998
Chicago, Illinois	4,179	3,631	6,724
Cristobal, Canal Zone	5,214	4,531	8,389
Los Angeles, California	2,557	2,222	4,114
Miami, Florida	4,856	4,220	7,813
New York, New York	4,959	4,309	7,979
Portland, Oregon	2,595	2,255	4,175
San Diego, California	2,610	2,268	4,199
San Francisco, California	2,397	2,083	3,857
Seattle, Washington	2,679	2,328	4,311
Vancouver, B.C.	2,709	2,354	4,359
Tijuana, Mexico	2,616	2,273	4,209
Washington, D.C.	4,829	4,196	7,770
London, England	7,226	6,279	11,627
Bombay, India	8,010	6,960	12,888
Ghanzi, Botswana 1/	12,417	10,790	19,979
Equator, due south of Honolulu	1,470	1,277	2,367
North Pole	4,740	4,119	7,631
OTHER DISTANCES			
Hilo to --			
Los Angeles, California	2,447	2,126	3,937
San Francisco, California	2,315	2,012	3,725
Kure Atoll to --			
Cape Kumukahi, Puna, Hawaii 2/	1,523	1,323	2,451
Log Point, Elliot Key, Florida 3/	5,852	5,085	9,416
Tokyo, Japan	2,486	2,160	4,000
West Quoddy Head, Maine	5,788	5,030	9,313

1/ Ghanzi, Botswana is Honolulu's antipode, that is, the point precisely opposite to it on the globe.

2/ Cape Kumukahi and Kure Atoll are the points farthest apart in the Hawaiian Archipelago and State of Hawaii.

3/ Log Point and Kure Atoll are the points farthest apart in the 50 states.

Source: U.S. Department of the Interior, Geological Survey, *Elevations and Distances in the United States* (1980), pp. 22-23, and records; E. H. Bryan, Jr., *American Polynesia and the Hawaiian Chain* (1942), pp. 38, 42, and 134.

Table 5.02-- LATITUDES AND LONGITUDES OF SELECTED PLACES

Island and place	Latitude (North)	Longitude (West)
Hawaii:		
Hilo (International Airport)	19°43'	155°04'
Cape Kumukahi	19°31'	154°49'
Ka Lae	18°56'	155°41'
Keahole Point	19°44'	156°04'
Upolu Point	20°16'	155°51'
Geographic center of State (off Maui)	20°15'	156°20'
Maui:		
Wailuku	20°53'	156°30'
Kahului (Airport)	20°54'	156°26'
Hana	20°45'	155°59'
Cape Hanamanioa	20°35'	156°25'
Lahaina	20°52'	156°41'
Kahoolawe:		
Puu Moaulanui	20°34'	156°34'
Lanai:		
Airport	20°48'	156°57'
Molokai:		
Kaunakakai	21°05'	157°02'
Laaupoint	21°06'	157°19'
Cape Halawa	21°10'	156°43'
Oahu:		
Honolulu: International Airport	21°20'	157°55'
Aloha Tower	21°19'	157°52'
Kaena Point	21°35'	158°17'
Kahuku Point	21°43'	157°59'
Makapuu Point	21°19'	157°39'
Diamond Head	21°16'	157°49'
Kauai:		
Lihue (Kauai Airport)	21°59'	159°21'
Mana	22°02'	159°46'
Kilauea Point	22°14'	159°24'
Niihau:		
Puuwai	21°54'	160°12'
Kure Atoll	28°25'	178°22'

Source: U.S. Board on Geographic Names, *Gazetteer No. 24, Hawaiian Islands* (1956); U.S. Geological Survey, *Elevations and Distances in the United States* (1980), pp. 17 and 22-23; U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary with Comparative Data, 1984* for Hilo, Kahului, Honolulu, and Lihue; Bernice P. Bishop Museum, records; Hawaii State Department of Accounting and General Services, Survey Division, records.

**Table 5.03-- TIME DIFFERENTIALS BETWEEN HONOLULU AND
SELECTED CITIES**

City	June		December	
	Day	Hour	Day	Hour
Honolulu	Same	12:00 noon	Same	12:00 noon
Los Angeles	Same	3:00 p.m.	Same	2:00 p.m.
Denver	Same	4:00 p.m.	Same	3:00 p.m.
Houston	Same	5:00 p.m.	Same	4:00 p.m.
Chicago	Same	5:00 p.m.	Same	4:00 p.m.
Atlanta	Same	6:00 p.m.	Same	5:00 p.m.
Washington	Same	6:00 p.m.	Same	5:00 p.m.
New York	Same	6:00 p.m.	Same	5:00 p.m.
London	Same	11:00 p.m.	Same	10:00 p.m.
Singapore	Next	6:00 a.m.	Next	6:00 a.m.
Hong Kong	Next	6:00 a.m.	Next	6:00 a.m.
Manila	Next	6:00 a.m.	Next	6:00 a.m.
Tokyo	Next	7:00 a.m.	Next	7:00 a.m.
Sydney	Next	8:00 a.m.	Next	9:00 a.m.

Source: GTE Hawaiian Tel, The White Pages, *Oahu, June 1999-2000*, pp. 38, 41.

Table 5.04-- WIDTHS AND DEPTHS OF CHANNELS

Channel 1/	Width 2/		Depth 3/	
	Statute miles	Kilometers	Feet	Meters
Alenuihaha (Hawaii-Maui)	29.6	47.6	6,810	2,076
Alalakeiki (Kahoolawe-Maui)	6.7	10.8	822	251
Kealaikahiki (Kahoolawe-Lanai)	17.8	28.6	1,086	331
Auau (Lanai-Maui)	9.5	15.3	252	77
Kalohi (Lanai-Molokai)	9.2	14.8	540	165
Pailolo (Maui-Molokai)	8.8	14.2	846	258
Kaiwi (Molokai-Oahu)	25.8	41.5	2,202	671
Kauai (Oahu-Kauai)	72.1	116.0	10,890	3,319
Kaulakahi (Kauai-Niihau)	17.2	27.7	3,570	1,088
Niihau-Kaula	21.5	34.6	5,364	1,635
Niihau-Niihoa	133.9	215.5	14,550	4,435
Niihoa-Necker I.	179.6	289.0	12,600	3,840
Necker I.-French Frigate Shoals	100.3	161.4	12,780	3,895
French Frigate Shoals-Gardner Pinnacles	137.0	220.5	11,448	3,489
Gardner Pinnacles-Marou Reef	155.5	250.3	12,300	3,749
Marou Reef-Laysan I.	65.9	106.1	8,280	2,524
Laysan I.-Lisianski I.	137.4	221.1	16,830	5,130
Lisianski I.-Pearl and Hermes Atoll	162.6	261.7	17,400	5,304
Pearl and Hermes Atoll-Midway Islands	86.9	139.9	15,840	4,828
Midway Islands-Kure Atoll	57.1	91.9	12,960	3,950

1/ Listed in geographic order, from east to west. The channels between major islands were measured between the following points:

- Alenuihaha: Upolu Pt., Hawaii, to Puhilele Pt., Maui;
- Alalakeiki: Lae o ka Ule, Kahoolawe, to Nukuele Pt., Maui;
- Kealaikahiki: Makaalae, Kahoolawe, to Kamaiki Pt., Lanai;
- Auau: Kikoa Pt., Lanai, to Lahaina, Maui;
- Kalohi: Wahie Pt., Lanai, to Kamalo, Molokai;
- Pailolo: Lipoa Pt., Maui, to Pohakuloa, Molokai;
- Kaiwi: Ilio Pt., Molokai, to Makapuu Pt., Oahu;
- Kauai: Kaena Pt., Oahu, to Kamilo Pt., Kauai;
- Kaulakahi: Mana Pt., Kauai, to Kaunuopou, Niihau.

2/ Width measured in statute miles between designated points on National Ocean Survey and Coast and Geodetic Survey charts. Width in kilometers calculated from miles (1 mile = 1.60934 km.).

3/ Depths given are the deepest soundings noted at or near the line joining the two designated points, on National Ocean Survey and Coast and Geodetic Survey charts. Depths measured in fathoms and converted to feet and meters (1 fathom = 6 feet = 1.8288 meters).

Source: Compiled by Lee S. Motteler, Geography and Map Division, Bernice P. Bishop Museum, in November 1980.

Table 5.05-- GENERAL COASTLINE AND TIDAL SHORELINE OF COUNTIES AND ISLANDS

County and island	General coastline 1/		Tidal shoreline 2/	
	Statute miles	Kilometers 3/	Statute miles	Kilometers 3/
State total	750	1,207	1,052	1,693
Counties:				
Hawaii	266	428	313	504
Maui, including Kalawao	210	338	343	552
Honolulu	137	220	234	377
Kauai	137	220	162	261
Islands: 4/				
Hawaii	266	428	313	504
Maui	120	193	149	240
Kahoolawe	29	47	36	58
Lanai	47	76	52	84
Molokai	88	142	106	171
Oahu	112	180	209	336
Kauai	90	145	110	177
Niihau	45	72	50	80
Kaula	2	3	2	3
Northwestern Hawaiian Islands 5/	25	40	25	40
Niihau	3	5	3	5
Necker Island	2	3	2	3
French Frigate Shoals	6	10	6	10
Laysan Island	6	10	6	10
Lisianski Island	3	5	3	5
Kure Atoll	5	8	5	8

1/ Figures are lengths of general outline of seacoast. Data for the four islands of Maui County are not consistent with the reported county total.

2/ Shoreline of outer coast, offshore islands, bays, rivers, and creeks is included to the head of tidewater or to a point where tidal waters narrow to a width of 100 feet.

3/ Derived from data expressed in statute miles; independently rounded and accordingly may not add exactly to indicated totals and subtotals. 1 mi. = 1.609 km.

4/ Data are not available for five minor islands: Molokini, Lehua, Gardner Pinnacles, Maro Reef, and Pearl and Hermes Atoll.

5/ Excludes the Midway Islands, which are part of the Hawaiian Archipelago but not legally part of the State of Hawaii. Midway has a general coastline of 20 miles and a tidal shoreline of 33 miles.

Source: U.S. Department of Commerce, National Ocean Survey, *The Coastline of the United States* (1975) and records.

**Table 5.06-- LAND AND WATER AREA WITHIN
THE FISHERY CONSERVATION ZONE**

[Land and water area within the 200 nautical mile Fishery Conservation Zone surrounding the
Hawaiian Archipelago]

Unit	Total area	Land area	Water area
Square nautical miles	634,023	4,852	629,171
Square statute miles	839,623	6,425	833,198
Square kilometers	2,174,626	16,641	2,147,985

Source: Marine Surveys and Maps, National Ocean Survey, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, information supplied September 15, 1978.

Table 5.07-- LAND AND WATER AREA OF COUNTIES: 1990

[See maps on pages 6 and 7]

Measurement unit and type of area	State total	Hawaii	Maui	Kalawao	Honolulu	Kauai
Square miles:						
Land	6,423.4	4,028.2	1,159.3	13.2	600.2	622.5
Inland water 1/	35.9	4.4	3.6	-	19.0	8.9
Territorial water 2/	4,472.4	1,054.3	1,236.0	39.1	1,507.8	635.1
Square kilometers:						
Land	16,636.5	10,433.1	3,002.5	34.2	1,554.5	1,612.2
Inland water 1/	92.9	11.5	9.3	-	49.2	22.9
Territorial water 2/	11,583.4	2,730.7	3,201.2	101.3	3,905.2	1,644.9
Acres:						
Land	4,110,966	2,578,073	741,933	8,451	384,125	398,383
Inland water 1/	22,976	2,816	-	2,304	12,160	5,696
Territorial water 2/	2,862,336	674,752	791,040	25,024	964,992	406,464

1/ Lakes, streams, reservoirs, etc. Includes Pearl Harbor.

2/ Within three miles of coast.

Source: U.S. Bureau of the Census, *1990 Census of Population and Housing, Summary Population and Housing Characteristics, Hawaii*, 1990 CPH-1-13 (August 1991), table 15, and unpublished records.

Table 5.08-- LAND AREA OF ISLANDS: 1990

Island	Square miles 1/	Square kilometers	Acres 1/
STATE OF HAWAII	6,423.4	16,636.5	4,110,966
Hawaii	4,028.2	10,433.1	2,578,073
Maui	727.3	1,883.7	465,472
Molokini	0.036	0.093	23
Kahoolawe	44.6	115.5	28,543
Lanai	140.5	364.0	89,946
Molokai	260.0	673.5	166,425
Oahu	597.1	1,546.5	382,148
Kauai	552.3	1,430.5	353,484
Niihau	69.5	179.9	44,455
Lehua	0.444	1.149	284
Kaula	0.247	0.640	158
Northwestern Hawaiian Islands 2/	3.108	8.049	1,989
Nihoa	0.271	0.701	173
Necker Island	0.071	0.183	45
French Frigate Shoals	0.096	0.249	62
Gardner Pinnacles	0.009	0.024	6
Maro Reef	Awash	Awash	Awash
Laysan Island	1.588	4.114	1,017
Lisianski Island	0.601	1.556	384
Pearl and Hermes Atoll	0.139	0.359	89
Kure Atoll	0.333	0.863	213
OTHER ISLANDS 3/			
Baker, Howland, and Jarvis Islands	2.9	7.5	1,853
Johnston Atoll	1.1	2.8	692
Kingman Reef	0.4	1.0	247
Midway Islands	2.5	6.4	1,581
Palmyra Atoll	4.6	11.9	2,941

1/ Areas in square miles and acres were calculated directly from measurements in .001 square kilometers and independently rounded. 1 square mile = 640 acres = 2.58999 square kilometers.

2/ Exclusive of the Midway Islands, which are part of the Hawaiian Archipelago but not legally part of the State of Hawaii.

3/ In central Pacific, not legally part of the State of Hawaii.

Source: U.S. Bureau of the Census, *1990 Census of Population and Housing, Summary Population and Housing Characteristics, Hawaii*, 1990 CPH-1-13 (August 1991), table 15; *Population and Housing Unit Counts, United States*, 1990 CPH-2-1 (October 1993), table 1; Summary Tape File 1B; and letter from Geography Division, March 30, 1992.

**Table 5.09-- MAJOR AND MINOR ISLANDS IN THE
HAWAIIAN ARCHIPELAGO**

Classification	Number of islands		Land area (square miles)
	Total	Inhabited, 1990 1/	
All named islands	137	12	6,427.0
Major islands	8	7	6,419.4
Named minor islands 2/	129	5	7.6
Offshore of major islands	96	3	2.6
Northwestern Hawaiian Islands 3/	33	2	4.9
Part of State	28	1	2.9
Not part of State (Midway Islands)	5	1	2.0

1/ For populations, see present volume, table 1.05.

2/ For individual data, see DPED Report GN-6, pp. 3-7.

3/ Includes individual islets in the 10 Northwestern Hawaiian Islands.

Source: Hawaii State Department of Planning and Economic Development, *Geographic Names Approved, Second Quarter 1969* (Report GN-6, July 8, 1969), p. 8; *Data Book 1986*, table 152.

Table 5.10-- AREA AND DEPTH OF SELECTED CRATERS

Island and crater	Area (acres)	Maximum depth (feet)
Hawaii:		
Kilauea Caldera	2,319	476
Mokuaweoweo Crater 1/	2,221	572
Maui:		
Haleakala Crater 2/	12,575	3,028
Oahu:		
Diamond Head Crater	255	562
Koko Crater	133	968
Punchbowl Crater	62	140

1/ Data exclude North and South Pits.

2/ Data exclude Koolau and Kaupo Gaps.

Source: Measured from U.S. Geological Survey maps by the Hawaii State Department of Business, Economic Development & Tourism.

Table 5.11-- ELEVATIONS OF MAJOR SUMMITS

[Elevation of the highest point on each island and other important peaks]

Island and summit	Feet	Meters
Hawaii:		
Mauna Kea 1/	13,796	4,205
Mauna Loa	13,679	4,169
Hualalai	8,271	2,521
Kaumu o Kaleihohie	5,480	1,670
Kilauea (Uwekahuna)	4,093	1,248
Kilauea (Halemaumau Rim)	3,660	1,116
Kahoolawe:		
Puu Moaulanui	1,483	452
Puu Moaulaiki	1,434	437
Molokini	160	49
Maui:		
Haleakala (Red Hill)	10,023	3,055
Haleakala (Kaupo Gap)	8,201	2,500
Puu Kukui	5,788	1,764
Iao Needle	2,250	686
Lanai:		
Lanaihale	3,366	1,026
Molokai:		
Kamakou	4,961	1,512
Olokui	4,606	1,404
Kalaupapa Lookout	1,600	488
Mauna Loa (Kukui)	1,430	436
Oahu:		
Kaala	4,003	1,220
Puu Kalena	3,504	1,068
Konahuanui	3,150	960
Tantalus	2,013	614
Olomana	1,643	501
Koko Crater (Kohelepelepe)	1,208	368
Nuuanu Pali Lookout	1,186	361
Diamond Head	760	232
Koko Head	642	196
Punchbowl	500	152

Continued on next page.

Table 5.11-- ELEVATIONS OF MAJOR SUMMITS -- Con.

Island and summit	Feet	Meters
Kauai:		
Kawaikini	5,243	1,598
Waialeale	5,148	1,569
Kalalau Lookout	4,120	1,256
Haupu	2,297	700
Sleeping Giant (Nonou)	1,241	378
Niihau:		
Paniau	1,250	381
Lehua	699	213
Kaula	548	167
Nihoa:		
Millers Peak	903	275
Necker Island:		
Summit Hill	276	84
French Frigate Shoals:		
La Perouse Pinnacles	120	37
Gardner Pinnacles	190	58
Maro Reef	Awash	Awash
Laysan Island	40	12
Lisianski Island	40	12
Pearl and Hermes Atoll	10	3
Midway Islands	12	4
Kure Atoll	20	6

1/ According to the *1995 Guinness Book of Records* (p. 147), "The world's tallest mountain measured from its submarine base (3,280 fathoms) in the Hawaiian Trough to its peak is Mauna Kea ... with a combined height of 33,480 ft., of which 13,796 ft. are above sea level."

Source: Hawaii State Department of Accounting and General Services, Survey Division, data provided April 21, 1992; U.S. National Cartographic Information Center, data provided October 11, 1978; U.S. Geological Survey topographic maps, 1981-1984; Hawaiian Government Survey (for Nihoa and Molokini); U.S.S. Tanager survey, 1923 (for Necker Island, French Frigate Shoals, Laysan, Lisianski, Pearl and Hermes Atoll and Kure Atoll.)

Table 5.12-- MAJOR NAMED WATERFALLS, BY ISLANDS

Island	Waterfall	Height (feet)		Horizontal distance (feet)
		Sheer drop	Cascade	
Hawaii	Kaluahine	...	620	400
	Akaka	442	...	...
	Waiilikahi	320	...	6
Maui	Honokohau	...	1,120	500
	Waihiumalu	...	400	150
Molokai	Kahiwa	...	1,750	1,000
	Papalaua	...	1,200	500
	Waialele	...	500	150
Oahu	Kaliuwaa (Sacred)	1/ 80	1,520	3,000
Kauai	Waipoo (2 falls)	...	800	600
	Awini	...	480	500
	Hinalele	280	...	...
	Wailua	200	...	...

1/ Refers to northernmost fall of a cascade of six falls.

Source: U.S. Geological Survey, records; Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records; "Tall Falls", *The Honolulu Advertiser*, June 25, 1995, pp. A17 and A20.

Table 5.13-- MAJOR STREAMS, BY ISLANDS

Island	Feature or stream	Length or average discharge
Longest water feature (miles):		
Hawaii	Wailuku River	32.0
Maui	Kalialinui-Waiale Gulch	18.0
Kahoolawe	Ahupu Gulch	4.0
Lanai	Maunalei-Waialala Gulch	12.9
Molokai	Wailau-Pulena Stream	6.5
Oahu	Kaukonahua Stream (So. Fork)	33.0
Kauai	Waimea River-Poomau Stream	19.5
Niihau	Keanaulii-Puniopo Valley	5.9
Largest perennial stream (miles): 1/		
Hawaii	Wailuku River	22.7
Maui	Palikea Stream	7.8
Molokai	Wailau-Pulena Stream	6.5
Oahu	Kaukonahua Stream	30.0
Kauai	Waimea River	19.7
Streams with greatest average discharge 2/ (million gal./day):		
Hawaii	Wailuku River	250
Maui	Iao Stream	43
Molokai	Wailau Stream	30
Oahu	Waikele Stream	3/ 27
Kauai	Hanalei River	140

1/ Estimated on basis of drainage area rather than stream runoff. Other major streams include Wailoa River, Hawaii (1/2-mile long); Honokohau Stream (9.4 miles long) and Iao Stream (5), both on Maui; Halawa Stream (6.4), Waikolu Stream (4.7), and Pelekunu (2.3), all on Molokai; Waikele Stream (15.3), Kipapa Stream (12.8), Waiakakalaua Stream (11.8), Nuuanu Stream (4), and Ala Wai Canal (1.9), all on Oahu; and the Makaweli River (15.1), Wainiha River (13.8), Hanapepe River (13.3), and Wailua River (11.8), all on Kauai.

2/ Most recent available year.

3/ Most of discharge is from nearby groundwater outflow.

Source: Longest water feature from U.S. Geological Survey, records; other data from Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records.

Table 5.14-- LAKES AND LAKE-LIKE WATERS, BY ISLANDS

Island and lake	Type	Elevation (feet)	Area 1/ (acres)	Maximum depth (feet)
Hawaii:				
Green Lake	Lake	3	2	20
Lake Waiau 2/	Lake	13,020	2	10
Waiakea Pond	Tidal pond	(SL)	27	7
Maui:				
Kanaha Pond	Marsh	(SL)	41	3
Kealia Pond	Marsh	(SL)	500	(NA)
Waieleele	Pond	6,690	0.5	21
Molokai:				
Kauhako	Pool	(SL)	0.9	814
Kualapuu Reservoir	Reservoir	821	100	50
Meyer Lake	Impoundment	2,021	6-10	5
Oahu:				
Ho'omaluhia	Reservoir	202	90	90
Kaelepulu Pond	Lake	(SL)	198	(NA)
Kawainui Marsh	Marsh	(SL)	1,000	(NA)
Wahiawa Reservoir	Reservoir	842	302	85
Kauai:				
Nomilu Fishpond	Pond	(SL)	20	66
Waita Reservoir	Reservoir	241	424	23
Niihau:				
Halalii Lake	Playa	(SL)	841-865	(NA)
Halulu Lake	Playa	(SL)	182-371	(NA)
Laysan:				
Laysan Lagoon	Closed lagoon	(SL)	161	16

NA Not available.

SL Sea level.

1/ Ranges shown for Meyer Lake, Halalii Lake, and Halulu Lake reflect differences in estimates between sources.

2/ Highest lake in the State and third highest in the United States.

Source: J.A. Maciolek, *Lakes and Lake-like Waters of the Hawaiian Archipelago* (Bernice P. Bishop Museum, Occasional Papers, Vol. XXV, No. 1, April 30, 1982); *Data Book 1992*, table 143; Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, May 18, 1994.

Table 5.15-- LENGTH AND WIDTH OF SELECTED BEACHES

[Includes the longest white sand beach on each inhabited island, plus other important beaches]

Island and beach	Length (miles)	Width 1/ (feet)
Hawaii: Hapuna	0.5+	200+
Maui: Spreckelsville	2+	(NA)
Kaanapali	1.5	60-80
Lanai: Polihua	1.5+	(NA)
Molokai: Papohaku	2+	300
Oahu: Waikiki	2	(NA)
Waimanalo	3.5-4.5	(NA)
Sunset	2-3+	200
Kauai: Polihale to Kekaha	15	300
Polihale	3	300
Niihau: Keawanui	3.5	175

NA Not available.

1/ Summer averages. Many beaches in Hawaii are seasonally reduced in width by winter storms.

Source: Hawaii State Department of Planning and Economic Development, *Hawaii's Shoreline* (1965), pp. 33, 47, 55, 62, 68, and 100; John R. K. Clark, *Beaches of the Big Island* (1985), p. 132, *The Beaches of Maui County* (1980), pp. 10, 62, 84-85, and 114, *The Beaches of O'ahu* (1977), pp. 45, 125, and 177, and *Beaches of Kaua'i and Ni'ihau* (1990), pp. 48-49 and 84.

Table 5.16-- MISCELLANEOUS GEOGRAPHIC STATISTICS, BY ISLAND

Island	Extreme length (miles)	Extreme width (miles)	Miles of sea cliffs with heights 1,000 ft. or more 1/	Miles from coast of most remote point	Percent of area within 5 miles of coast
State total	...	...	33	28.5	48.6
Hawaii	93	76	4	28.5	30.0
Maui	48	26	-	10.6	76.1
Kahoolawe	11	6	-	2.4	100.0
Lanai	18	13	1	5.2	100.0
Molokai	38	10	14	3.9	100.0
Oahu	44	30	-	10.6	79.0
Kauai	33	25	11	10.8	65.0
Niihau	8	6	3	2.4	100.0
	Percent of area with elevation --			Percent of area with slope --	
	Less than 500 feet	2,000 feet or more	Approximate mean altitude (feet)	Less than 10 percent	20 percent or more
State total	20.8	50.9	3,030	63.5	17.0
Hawaii	12.0	68.4	3,950	76.0	4.0
Maui	24.9	41.4	2,390	38.5	36.0
Kahoolawe	38.9	0.0	600	60.0	9.0
Lanai	24.8	6.3	1,140	61.0	16.0
Molokai	37.3	17.8	1,150	53.0	26.0
Oahu	45.3	4.6	860	42.5	45.5
Kauai	35.6	24.0	1,380	33.5	50.5
Niihau	78.2	0.0	530	68.0	12.5

1/ According to Lee S. Motteler, Geography and Map Division, Bernice P. Bishop Museum, the sea cliffs along the northeastern coast of Molokai between Umilehi Point and Puukaoku Point drop 3,250 feet at an average slope of 58 degrees. These cliffs have been described by *The Guinness Book of Records* (1995 edition, p. 154) as "the highest sea cliffs in the world."

Source: Hawaii State Department of Planning and Economic Development, *Hawai'i the Natural Environment* (1974), p. 19; U.S. Department of the Interior, Geological Survey, *Elevations and Distances in the United States* (1978), pp. 4-5.

Table 5.17-- VOLCANIC ERUPTIONS: 1969 TO 1999

[Four volcanoes have erupted in historical times: Haleakala, last active around 1790; Hualalai, last active in 1800-1801; and Kilauea and Mauna Loa, both active in recent years and included in this table. Complete through December 31, 1999]

Volcano and date of outbreak	Repose period since previous eruption (months)	Duration (days)	Location 1/	Elevation (meters)	Area (square km.)	Volume (mil. cubic meters)
Mauna Loa:						
1975: July 5	301	<1	S	3,900	13.5	30.0
1984: March 25	104	22	S, ER	4,030-2,870	28.5	176.0
Kilauea:						
1969: Feb. 22	4.0	6	ER	930-870	6.0	16.1
May 24	2.0	874	ER	940	50.0	185.0
1971: Aug. 14	-	<1	C	1,100-1,080	3.1	9.1
Sept. 24	-	5	C, SWR	1,120-820	3.9	7.7
1972: Feb. 3	4.3	900	ER	940	46.0	162.0
1973: May 5	-	<1	ER	1,000-980	0.3	1.2
Nov. 10	-	30	ER	980-870	1.0	2.7
1974: July 19	-	3	C, ER	1,080-980	3.1	6.6
Sept. 19	2.0	<1	C	1,100	1.0	10.2
Dec. 31	3.4	<1	SWR	1,080	7.5	14.3
1975: Nov. 29	11.0	<1	C	1,080-1,060	0.3	0.2
1977: Sept. 13	21.5	18	ER	620-480	7.8	32.9
1979: Nov. 16	26.3	1	ER	980-960	0.3	0.6
1982: April 30	29.5	<1	C	1,080	0.3	0.5
Sept. 25	4.8	<1	C	1,080	0.8	3.0
1983: Jan. 3 2/	3.3	6,206	ER	780-650	105.5	1,893.8

1/ C, caldera; ER, east rift; S, summit; SWR, southwest rift.

2/ Still in progress. There have been 55 separate episodes, they destroyed 181 housing units and added 205 hectares to the area of the island.

Source: Gordon A. Macdonald, Agatin T. Abbott, and Frank L. Peterson, *Volcanoes in the Sea*, 2nd ed. (1983), pp. 64-65 and 80-81; U.S. Geological Survey, Hawaiian Volcano Observatory, records; and <http://hvo.wr.usgs.gov/>.

Table 5.18-- MAJOR EARTHQUAKES: 1838 TO 2000

[Includes all earthquakes with magnitudes of 6.0 or greater, 1838 to 1983, and 5.0 or greater, 1984 to 1999. Except for the earthquake of April 2, 1868, magnitudes of earthquakes prior to 1929 are conjectural. Complete through April 10, 2000]

Date and time (HST)	Location	Magnitude (Richter scale)
1838: December 12	Hawaii	6.0
1841: April 7	Hawaii	6.0
1852: March 31	Hawaii	6.0
1868: March 28	Hawaii	6.5
April 2	Hawaii	7.5
1871: February 19	Molokai or Maui	6.5
1875: November 23	Hawaii	6.0
1887: January 24	Hawaii	6.0
1913: October 25	Hawaii	6.5
1918: November 1	Hawaii	6.5
1919: September 14	Hawaii	6.5
1929: October 5	Hawaii	6.5
1938: January 23	N. of Pauwela Point, Maui	6.75
1940: June 17	Hawaii	6.0
1941: September 28	Hawaii	6.0
1950: May 30	Hawaii	6.25
1951: April 23	Hawaii	6.5
August 21	Hawaii	6.9
1952: May 23	Hawaii	6.0
1954: March 30	Hawaii	6.0
March 30	Hawaii	6.5
1961: September 25	Hawaii	5.75-6
1962: June 28	Hawaii	6.1
1973: April 26	Honomu, Hawaii	6.2
1975: Nov. 29, 4:47 AM	Puna, Hawaii	7.2
1983: Nov. 16, 6:13 AM	S.E. flank of Mauna Loa	6.7
1984: June 8, 5:34 PM	80 miles S. of Honolulu	5.3
1986: April 26, 7:19 AM	28 miles N.E. of Maui	5.1
1987: Feb. 3, 4:22 PM	26 miles S. of Kahoolawe	5.0
1989: June 25, 5:27 PM	Kalapana area	6.1
1994: Feb. 1, 12:01 AM	Offshore, 12 miles S. of Kilauea	5.2
1997: June 30, 5:47 AM	5 miles W. of Kalapana	5.2
1999: April 16, 2:56 PM	4 miles N. of Pahala	5.6
2000: April 1, 8:18 PM	S. Flank of Kilauea Volcano	5.0

Source: Augustine S. Furumoto, N. Norby Nielsen, and William R. Phillips, *A Study of Past Earthquakes, Isoseismic Zones of Intensity and Recommended Zones for Structural Design for Hawaii* (University of Hawaii, Center for Engineering Research, Engineering Bulletin, June 15, 1972); information supplied by Wm. Mansfield Adams and Augustine S. Furumoto, Institute of Geophysics, University of Hawaii; Hawaii Institute of Geophysics, records; U.S. Geological Survey, National Earthquake Information Service; U.S. Geological Survey, Hawaiian Volcano Observatory, records. <http://hvo.wr.usgs.gov/earthquakes/felt/currEQ.html>.

**Table 5.19-- EARTHQUAKES WITH HONOLULU INTENSITIES OF
V OR GREATER: 1859 TO 1999**

[Complete through December 31, 1999]

Date	Epicentral location	Magnitude (Richter scale)	Honolulu average intensity (Modified Mercalli Scale 1/)
1861: Dec. 5	Molokai-Lanai vic. (?)	(NA)	Mid V
Dec. 15	Molokai-Lanai vic. (?)	(NA)	Lower V - mid V
1868: Apr. 2	SE coast of Hawaii	7.5	Upper IV - lower V
Apr. 4	Maui group vicinity (?)	(NA)	Lower V
1871: Feb. 19	S coast of Lanai	7.0	Upper VI - lower VII
1895: Dec. 8	Oahu vicinity (?)	(NA)	Mid V
1926: Mar. 19	N of Kohala, Hawaii	(NA)	Upper IV - lower V
1929: Oct. 5	W of Kona, Hawaii	6.5	Lower V
1938: Jan. 22	N of Maui	6.8	Upper V - lower VI
1948: June 28	S coast of Oahu	4.8	Mid VI
1964: Oct. 11	Ka Lae, Hawaii	5.5	Upper IV - lower V
1973: Apr. 26	Hamakua coast, Hawaii	6.2	Mid V
1981: Mar. 5	Kalohi Channel	5.0	Mid V

NA Not available.

1/ Modified Mercalli Scale of 1931, 1956 abridged version further simplified. This scale, which extends from I to XII, reads in part:

IV. Hanging objects swing. Vibration like passing of heavy trucks or sensation of a jolt. Standing autos rock. Windows, dishes, doors rattle. Crockery clashes. In the upper part of range wooden construction creaks.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids distributed, some spilled. Small unstable objects displaced or upset. Doors, shutters, pictures swing. Pendulum clocks stop.

VI. Felt by all. Many frightened, run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books thrown off shelves, pictures off walls. Furniture moved, overturned. Weak plaster and masonry cracked. Small bells ring. Trees, bushes noticeably shaken.

VII. Difficulty in standing. Noticed by drivers of autos. Hanging objects quiver. Furniture broken. Damage to weak masonry. Weak chimneys broken at roof line. Fall of plaster, loose bricks, etc. Some cracks in ordinary masonry. Waves on ponds. Small slides on sand and gravel banks. Large bells ring. Irrigation ditches damaged.

Source: Doak C. Cox, "Earthquake Experience in Honolulu", *The Hawaiian Journal of History*, Vol. 21 (1987), pp. 98-109; U.S. Geological Survey, Hawaiian Volcano Observatory, records.

**Table 5.20-- TSUNAMIS WITH RUN-UP OF 2 METERS (6.6 FEET) OR MORE:
1819 TO 1999**

[Complete through December 31, 1999]

Date	Place of observation	Maximum height in Hawaii 1/		Deaths in Hawaii	Damage in Hawaii
		Meters	Feet		
1819: April 12 2/	W. Hawaii	2.0	7	-	Unknown
1837: Nov. 7	Hilo	6.0	20	16	200 houses
1841: May 17	Hilo	4.6	15	-	Unknown
1868: April 2	Ka'u	12.2	40	47	Great locally
Aug. 14	Hilo	4.6	15	-	Severe
1869: Aug. 24	S.E. Puna	9.1	30	-	Some
1877: May 10	Hilo	4.9	16	5	Severe; \$14,000
1878: Jan. 20	N. Oahu	3.0	10	-	Some houses
1896: June 15	Kona	9.1	30	-	Unknown
1906: Jan. 31	Hilo	3.6	12	-	None
Aug. 16	Maalaea	3.6	12	-	Some
1919: April 9	S. Kona	4.3	14	-	None
April 30	Ka'u	4.2	14	-	None
1922: Nov. 11	Hilo	2.1	7	-	Minor
1923: Feb. 4	Hilo	6.1	20	1	Severe; \$1,500,000
1924: May 30	Lanai	5.0	16	-	Great locally
1933: March 2	Kona	2.9	10	-	Some
1946: April 1	N.E. Hawaii	17.0	56	159	\$26,000,000
1952: Nov. 4	Hawaii	6.1	20	-	\$800,000-1,000,000
1957: March 9	Haena	16.0	52	1	\$5,000,000
1960: May 22	Hilo	10.5	34	61	\$23,000,000
1964: March 27	N. Oahu	4.8	16	-	\$67,590
1975: Nov. 29	Ka'u	14.6	48	2	\$1,500,000

1/ Data before 1946 are approximate and probably low in many cases.

2/ Earliest tsunami for which definite information exists. A tsunami observed at Ho'okena in 1813 or 1814 may have exceeded two meters.

Source: George Pararas-Carayannis, *Catalog of Tsunamis in the Hawaiian Islands* (U.S. Coast and Geodetic Survey, May 1969); Harold G. Loomis, *The Tsunami of November 29, 1975 in Hawaii* (Hawaii Institute of Geophysics, December 1975), pp. 1 and 10; D.C. Cox and J. Morgan, *Local Tsunamis and Possible Local Tsunamis in Hawaii* (Hawaii Institute of Geophysics, Report HIG 77-14, November 1977); Doak C. Cox, *Tsunami Casualties and Mortality in Hawaii* (University of Hawaii, Environment Center, June 1987), p. 39; U.S. Geological Survey, Hawaiian Volcano Observatory, records.

Table 5.21-- MAJOR DAMS: 1994

Name	Location	Height (ft.)	Length (ft.)	Volume of water impounded (acre-ft.)
Wahiawa Dam	Wahiawa, Oahu	98	460	7,761
Waita	Koloa, Kauai	28	3,250	6,500
Kualapuu	Kualapuu, Molokai	58	7,100	4,265
Alexander Dam	Kalaheo, Kauai	119	600	2,500
Ho'omaluhia Dam	Luluku, Oahu	132	2,200	2,500
Nuuanu No. 4	Honolulu, Oahu	73	1,730	1,420
Waimanalo Dam	Waimanalo, Oahu	62	2,118	182

Source: Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records.

Table 5.22-- FRESH WATER USE, BY TYPE, BY ISLANDS: 1995

[Million gallons per day]

Use	State total	Hawaii	Maui	Lanai	Molokai	Oahu	Kauai	Niihau 1/
Total	981.44	108.52	356.06	3.44	9.33	264.23	239.86	-
Ground water	498.34	104.14	120.18	3.44	4.77	227.85	37.96	-
Domestic	133.06	17.17	19.60	0.52	1.48	86.39	7.90	-
Agricultural	180.49	12.63	88.85	1.95	3.18	52.59	21.29	-
Industrial	25.38	0.33	2.27	0.01	0.01	17.27	5.49	-
Thermoelectric	67.34	67.34	-	-	-	-	-	-
Commercial	92.07	6.67	9.46	0.96	0.10	71.60	3.28	-
Surface water	483.10	4.38	235.88	-	4.56	36.38	201.90	-
Domestic	1.33	1.33	-	-	-	-	-	-
Agricultural	481.30	3.05	235.47	-	4.50	36.38	201.90	-
Industrial	0.05	-	-	-	0.05	-	-	-
Thermoelectric	-	-	-	-	-	-	-	-
Commercial	0.42	-	0.41	-	0.01	-	-	-

1/ 1995 water-use data for Niihau not compiled.

Source: Data compiled by the U.S. Geological Survey and provided by the Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records.

**Table 5.23-- WATER SERVICES AND CONSUMPTION, FOR COUNTY
WATERWORKS: 1997 TO 1999**

[Services as of June 30; consumption for fiscal years]

Geographic area	Number of services			Consumption (million gallons)		
	1997	1998	1999	1997	1998	1999
State total	2/ 231,260	233,043	234,893	71,810	73,301	76,610
City and County of Honolulu	152,692	153,649	155,935	48,624	49,265	51,614
Honolulu District 1/	61,180	61,205	61,406	24,420	24,587	25,156
Rest of Oahu	91,512	92,444	94,529	24,204	24,678	26,458
Hawaii County	2/ 33,402	33,716	34,254	7,804	8,159	8,076
Kauai County	16,860	16,958	17,420	3,944	4,148	4,373
Maui County	28,306	28,720	29,333	11,438	11,729	12,547
Maui	26,795	27,205	27,809	11,110	11,387	12,199
Molokai	1,511	1,515	1,524	328	342	348

1/ Maunaloa to Moanalua.

2/ Revised.

Source: Data compiled by Hawaii State Department of Business, Economic Development & Tourism from City and County of Honolulu Board of Water Supply, County of Hawaii Department of Water Supply, County of Kauai Department of Water, and County of Maui Department of Water Supply.

Table 5.24-- HAZARDOUS WASTE SITES: 1994 TO 1998

[Includes both proposed and final sites
listed on the National Priorities List for the Superfund Program]

Subject	1994	1995	1996	1997	1998
Number of sites	4	4	4	4	1/ 4
Rank (among the 50 states)	46	45	45	45	45

1/ The United States total was 1,245 sites, including one site in the District of Columbia.

Source: Data from the U.S. Environmental Protection Agency, as cited in *Statistical Abstract of the United States* for 1995 (p.237), 1996 (p. 238), 1997 (p. 238), 1998 (p. 246), and 1999 (p. 250).

**Table 5.25-- WATER QUALITY AT PUBLIC BEACHES, BY ISLANDS:
1998 AND 1999**

Island	Number of locations	Number of samples	Enterococci density 1/			
			Lowest 2/	Highest 3/	Number over 7	Mean 4/
1998						
State total	159	2,499	0.6	258.4	30	2.5
Hawaii	45	536	0.6	83.2	9	2.5
Hilo Shoreline	20	239	0.8	83.2	9	4.8
Kona Shoreline	25	297	0.6	3.0	-	1.5
Maui	48	525	0.6	39.6	1	1.7
Lanai	-	-	(X)	(X)	(X)	(X)
Molokai	-	-	(X)	(X)	(X)	(X)
Oahu	36	1,081	0.6	258.4	6	2.9
Kauai	30	357	0.6	75.8	5	2.6
1999						
State total	105	3,158	0.3	872.3	21	2.2
Hawaii	22	618	0.3	14.5	3	1.8
Hilo Shoreline	11	313	0.5	7.9	1	2.6
Kona Shoreline	11	305	0.3	14.5	2	1.2
Maui	25	945	0.5	3.9	-	1.2
Lanai	-	-	(X)	(X)	(X)	(X)
Molokai	-	-	(X)	(X)	(X)	(X)
Oahu	39	1,042	0.4	872.3	11	2.7
Kauai	19	553	0.9	139.7	7	4.4

X Not applicable.

1/ Geometric mean, number per 100 ml. The geometric mean standard for Enterococci density is 7 per 100 ml.

2/ The lowest average value in 1998 was reported at multiple beaches on the islands of Hawaii, Kauai, Maui and Oahu. The lowest average value in 1999 was reported at Kona Coast Park on the island of Hawaii.

3/ The highest values, both in 1998 and 1999, were those reported for the Ala Wai Canal at the McCully Street Bridge on Oahu.

4/ Not weighted by number of samples.

Source: Hawaii State Department of Health, Clean Water Branch, records.

**Table 5.26-- WATER QUALITY AT SELECTED PUBLIC BEACHES:
1998 AND 1999**

Island and beach	Number of samples		Enterococci density 1/	
	1998	1999	1998	1999
Hawaii:				
Hapuna Beach	12	38	1.4	0.5
Kahaluu Beach	12	39	2.7	3.7
Kealakekua Bay (off curio stand)	12	-	1.9	(X)
Hilo Bay (Mooheau Park)	-	-	(X)	(X)
Spencer Beach Park	12	46	2.5	2.6
Maui:				
Kapalua (Fleming) Beach (north)	12	48	0.9	1.0
Kihei (north)	12	-	2.0	(X)
Makena Beach	12	-	0.8	(X)
Seven Pools	9	3	1.5	0.5
Sheraton Kaanapali (shoreline)	12	39	1.2	0.8
Lanai:				
Hulopoe Bay	-	-	(X)	(X)
Molokai:				
Kaunakakai Harbor	-	-	(X)	(X)
Oahu:				
Ala Moana Park (center)	-	4	(X)	9.7
Ewa Beach Park	-	7	(X)	0.8
Haleiwa Beach	23	25	1.6	3.0
Hanauma Bay	46	49	3.4	4.2
Kailua Beach Park	36	50	2.2	1.9
Kuhio Beach	46	49	5.0	8.7
Makaha Beach	-	-	(X)	(X)
Waimea Beach	44	41	2.0	3.2
Kauai:				
Anini Park Pavilion	12	43	1.4	1.6
Kalapaki Beach (middle)	12	50	6.2	4.7
Kekaha (Oomano Point)	12	-	0.9	(X)
Poipu Beach Pavilion	12	43	1.0	1.4
West of Lydgate Park (wading pool)	13	50	1.5	1.2

X Not applicable.

1/ Geometric mean, number per 100 ml. The geometric mean standard for Enterococci density is 7 per 100 ml.

Source: Hawaii State Department of Health, Clean Water Branch, records.

**Table 5.27-- REFUSE AND SEWAGE STATISTICS FOR OAHU:
1989 TO 1999**

[Years ended June 30]

Year	Tons of municipal solid waste delivered 1/			Sewage treated 2/ (millions of gallons)
	Total	City and County refuse vehicles	Other vehicles	
1989	778,673	302,851	474,822	39,918
1990	825,058	276,178	548,880	41,763
1991	1,015,842	293,857	721,985	44,484
1992	1,049,647	331,269	718,378	42,705
1993	1,023,113	322,901	700,212	42,415
1994	1,017,367	331,602	685,765	42,756
1995	1,017,709	325,381	692,328	43,175
1996	959,793	288,057	671,736	41,403
1997	945,081	302,078	643,003	42,616
1998	861,851	295,117	566,714	41,289
1999	830,035	284,007	546,028	40,750

Year	Sewage pumped 2/ (millions of gallons)	Miles of sewers 2/	City and County pump stations	City and County treatment plants
1989	51,623	1,805	59	14
1990	50,858	1,828	62	13
1991	52,849	1,859	64	13
1992	53,290	1,890	65	12
1993	52,480	1,914	67	11
1994	53,298	1,945	69	8
1995	53,088	1,893	64	8
1996	52,114	1,910	65	8
1997	54,197	1,940	63	8
1998	50,605	1,940	64	8
1999	49,379	1,970	65	8

1/ Excludes small landfill controlled by armed forces.

2/ Data limited to system maintained by the City and County of Honolulu, Department of Environmental Services.

Source: City and County of Honolulu, Department of Environmental Services.

Table 5.28-- AIR QUALITY IN DOWNTOWN HONOLULU: 1988 TO 1999

[Annual arithmetic means, in micrograms per cubic meter (mg/m^3), for particulate matter 10 microns or less in diameter (PM_{10}) and in parts per million (ppm) for carbon monoxide (CO).

Sampling is conducted about 46 feet above ground on the roof of the State Health Department building (Kinau Hale), 1250 Punchbowl Street, Honolulu, Hawaii]

Year	PM_{10} (mg/m^3) 1/	CO (ppm) 2/	Year	PM_{10} (mg/m^3) 1/	CO (ppm) 2/
1988	-	1.7	1994	14	0.8
1989	-	1.8	1995	14	0.8
1990	-	1.5	1996	14	0.8
1991	-	1.7	1997	8	0.8
1992	-	1.6	1998	9	0.8
1993	13	1.8	1999	14	0.6

1/ The State and Federal Ambient Air Standard for PM_{10} annual average is $50 mg/m^3$.

2/ There is no annual standard for CO. The State Ambient Air Standard for 1-hour CO is $9 ppm/m^3$ and the Federal standard is $35 ppm/m^3$.

Source: Hawaii State Department of Health, Clean Air Branch, records.

Table 5.29-- AIR QUALITY AT SPECIFIED LOCATIONS: 1998

[24-hour sampling, in micrograms per cubic meter]

Sampling station	PM 10			Sulfur dioxide		
	Annual range		Annual arithmetic average	Annual range		Annual arithmetic average
	Minimum	Maximum		Minimum	Maximum	
Oahu:						
Downtown Honolulu	4	28	9	-	8	2
Liliha	7	39	15	...	...	...
Pearl City	7	103	16	...	...	...
Kapolei	7	34	15	-	17	2
Makaiwa	...	...	...	-	24	3
West Beach 1/	8	43	16	-	16	4
Waimanalo 1/	11	31	20	...	...	...
Kauai:						
Lihue 1/	8	31	20	...	...	...

1/ Manual PM₁₀ samplers operated for 24 hours, once every 6 days in accordance with EPA guidelines.

Source: Hawaii State Department of Health, Clean Air Branch, records.

Table 5.30-- AIR QUALITY AT SPECIFIED LOCATIONS: 1999

[24-hour sampling, in micrograms per cubic meter]

Sampling station	PM 10			Sulfur dioxide		
	Annual range		Annual arithmetic average	Annual range		Annual arithmetic average
	Minimum	Maximum		Minimum	Maximum	
Oahu:						
Downtown Honolulu	6	43	14	-	8	2
Liliha	8	133	15	...	...	...
Pearl City	7	94	14	...	...	...
Kapolei	7	129	15	-	6	2
Makaiwa	...	...	...	-	11	2
West Beach 1/	6	21	13	-	6	1
Waimanalo 1/	8	33	18	...	...	...
Kauai:						
Lihue 1/	9	35	17	...	...	...

1/ Manual PM₁₀ samplers operated for 24 hours, once every 6 days in accordance with EPA guidelines.

Source: Hawaii State Department of Health, Clean Air Branch, records.

**Table 5.31-- ATMOSPHERIC CARBON DIOXIDE MEASUREMENTS AT
MAUNA LOA: ANNUAL MEAN VALUES, 1958 TO 1999**

[Parts per million]

Year	Annual average	Year	Annual average	Year	Annual average
1958	1/ 315.17	1972	327.26	1986	347.21
1959	315.83	1973	329.45	1987	348.98
1960	316.75	1974	1/ 329.72	1988	351.34
1961	317.49	1975	3/ 331.14	1989	352.89
1962	318.30	1976	332.04	1990	354.26
1963	318.83	1977	333.79	1991	355.45
1964	2/ 319.04	1978	335.35	1992	356.20
1965	319.87	1979	336.73	1993	356.90
1966	321.21	1980	338.72	1994	358.70
1967	322.02	1981	340.12	1995	360.62
1968	322.83	1982	341.21	1996	362.40
1969	323.93	1983	342.87	1997	363.54
1970	325.27	1984	344.48	1998	366.60
1971	326.17	1985	345.85	1999	368.03

1/ Based on data for 8 months.

2/ Based on data for 9 months.

3/ Based on data for 11 months.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Geophysical Monitoring for Climatic Change, records; provided by National Weather Service, Pacific Region, Honolulu (for 1958-1991), and by Mauna Loa Observatory (for 1992-1999).

Table 5.32-- TEMPERATURES AND PRECIPITATION FOR SELECTED PLACES

Island and station	Ground elevation (feet)	Average temperature 1/ (°F)		Extreme temperature of record (°F)		Average annual precipitation (inches)
		Coollest month	Warmest month	Lowest	Highest	
Hawaii:						
Hilo Airport	30	63.3	83.6	53	94	129
Hawaii Volcanoes Nat. Park Hdq.	3,970	57.6	63.2	31	93	101
Naalehu	800	70.2	75.1	50	93	47
Kailua	30	72.1	77.3	54	93	25
Puako 2/	5	73.1	79.8	52	98	10
Waimea (Kamuela)	2,670	61.3	66.8	34	90	31
Honokaa	1,070	67.6	75.5	(NA)	(NA)	86
Mauna Kea summit 3/	13,796	31.3	42.5	11	66	20
Maui:						
Hana Airport	60	71.4	77.3	50	94	83
Haleakala summit	10,025	42.6	50.0	14	73	44
Kihei 4/	85	70.9	78.4	49	98	13
Kahului Airport	40	63.5	87.9	48	97	21
Lahaina	45	71.5	78.0	52	97	15
Molokai:						
Kaunakakai	10	(NA)	(NA)	(NA)	(NA)	14
Molokai Airport	450	70.2	77.6	48	91	27
Lanai:						
Lanai City	1,620	65.8	72.8	46	88	37

Continued on next page.

Table 5.32-- TEMPERATURES AND PRECIPITATION FOR SELECTED PLACES -- Con.

Island and station	Ground elevation (feet)	Average temperature 1/ (°F)		Extreme temperature of record (°F)		Average annual precipitation (inches)
		Coollest month	Warmest month	Lowest	Highest	
Oahu:						
Honolulu International Airport	10	65.5	88.0	53	95	22
Waikiki (Honolulu Zoo)	10	72.8	80.3	51	95	25
Manoa (Lyon Arboretum)	500	69.9	76.1	49	96	158
Kaneohe (State Hospital)	200	71.0	77.5	43	93	71
Kahuku	25	71.6	78.8	49	95	40
Wheeler AFB	845	68.2	75.5	52	89	40
Waianae	10	72.1	79.7	45	96	20
Kauai:						
Kilauea (town)	315	68.7	75.6	49	94	68
Lihue Airport	100	64.7	84.8	50	90	43
Poipu (Makahuena Pt.)	50	72.1	79.4	50	95	35
Kekaha	9	71.0	78.5	48	95	21
Kokee (Kanalohuluhulu)	3,600	54.7	63.8	29	86	70
Northwestern Hawaiian Islands:						
Midway	10	65.0	78.6	52	89	44

NA Not available.

1/ For some stations, data represent 30-year normals.

2/ Temperature data are for Mahukona.

3/ Based on incomplete and non-continuous data for 1966-1972. Precipitation estimated.

4/ Temperature data refer to Puunene Airport.

Source: Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records;
Hawaii State Climatology Office, Department of Meteorology, University of Hawaii, records.

**Table 5.33-- CLIMATIC NORMALS, MEANS, AND EXTREMES FOR HILO,
KAHULUI, HONOLULU, AND LIHUE AIRPORTS**

Subject	Hilo	Kahului	Honolulu	Lihue
Normal temperatures (°F):				
Daily maximum	81.5	83.9	84.4	81.2
Daily minimum	66.4	67.2	70.0	69.9
Monthly: Coolest month 1/	71.7	71.7	72.9	71.6
Warmest month 1/	76.3	79.3	81.4	79.5
Annual 1/	74.0	75.6	77.2	75.6
Extreme temperatures (°F):				
Record highest	94	97	95	90
Record lowest	53	48	53	50
Normal degree days, base 65°F:				
Heating	-	-	-	-
Cooling	3,284	3,883	4,474	3,883
Precipitation (inches):				
Normal	129.19	20.92	22.02	43.00
Maximum monthly	50.82	14.46	20.79	22.91
Minimum monthly	0.13	0.00	T	T
Maximum in 24 hours	22.30	7.01	17.07	11.54
Normal relative humidity (percent)	79	73	68	75
Wind speed (m.p.h.):				
Mean	7.4	14.6	11.4	12.8
Maximum 2-second	31	38	33	36
Percent of possible sunshine	40	67	71	58
Mean number of days:				
Clear	35.5	130.5	90.0	55.3
Partly cloudy	131.3	145.2	179.8	183.2
Cloudy	195.3	89.5	92.0	123.2
Precipitation .01 inch or more	273.3	100.2	100.7	199.8
Thunderstorms	9.7	4.0	6.7	7.8
Temperature maximum 90° and above	1.0	23.5	31.4	0.1

T Trace amount.

1/ Normal dry bulb temperature, which is the temperature of the ambient air.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary with Comparative Data, 1999* for Hilo, Kahului, Honolulu, and Lihue.

Table 5.34-- MONTHLY AND ANNUAL CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT

Month	Normal temperature (°F)			Extreme temperature (°F)		Precipitation (inches)			
	Daily maximum	Daily minimum	Monthly 1/	Highest daily maximum	Lowest daily minimum	Normal total	Maximum monthly	Minimum monthly	Maximum in 24 hours
January	80.1	65.6	72.9	88	53	3.55	14.74	0.18	6.72
February	80.5	65.4	73.0	88	53	2.21	13.68	0.06	6.88
March	81.6	67.2	74.4	88	55	2.20	20.79	0.01	17.07
April	82.8	68.7	75.8	91	57	1.54	8.92	0.01	4.21
May	84.7	70.3	77.5	93	60	1.13	7.23	0.05	3.44
June	86.5	72.2	79.4	92	65	0.50	2.46	T	2.28
July	87.5	73.5	80.5	94	66	0.59	2.33	0.03	2.20
August	88.7	74.2	81.4	93	67	0.44	3.08	T	2.35
September	88.5	73.5	81.0	95	66	0.78	2.74	0.05	1.40
October	86.9	72.3	79.6	94	61	2.28	11.15	0.07	7.57
November	84.1	70.3	77.2	93	57	3.00	18.79	0.03	9.15
December	81.2	67.0	74.1	89	54	3.80	17.29	0.06	8.25
Annual	84.4	70.0	77.2	95	53	22.02	20.79	T	17.07

Continued on next page.

Table 5.34-- MONTHLY AND ANNUAL CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT -- Con.

Month	Relative humidity (percent)		Wind (miles/hour)		Percent of possible sunshine	Mean number of days		
	8 A.M.	2 P.M.	Mean speed	Maximum 2- minute speed		Clear	Cloudy	Precip. .01 inch or more
January	81	62	9.4	30	65	9.5	8.5	9.7
February	78	59	10.1	33	68	8.1	7.6	8.6
March	73	57	11.3	31	72	7.4	9.3	9.2
April	70	56	11.7	28	70	5.9	9.6	9.5
May	67	54	11.6	25	72	6.7	8.7	7.9
June	66	52	12.6	30	74	6.5	6.2	5.8
July	67	52	13.4	30	76	7.4	5.1	7.4
August	67	51	13.0	29	77	8.0	5.7	6.1
September	68	52	11.4	26	77	7.9	5.7	7.4
October	70	56	10.7	24	71	7.5	8.1	8.8
November	74	59	10.9	26	64	7.2	8.8	9.8
December	78	61	10.6	28	63	7.9	8.7	10.5
Annual	72	56	11.4	33	71	90.0	92.0	100.7

T Trace amount.

1/ Normal dry bulb.

2/ During period of record, 1999.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii 1999*.

Table 5.35-- AVERAGE TEMPERATURE, PERCENT OF POSSIBLE SUNSHINE, AND PRECIPITATION, FOR HONOLULU INTERNATIONAL AIRPORT: ANNUALLY, 1950 TO 1999

Year	Average temperature (°F)	Percent of possible sunshine	Precipitation (inches)	Year	Average temperature (°F)	Percent of possible sunshine	Precipitation (inches)
1950	75.7	(NA)	31.68	1975	76.2	62	24.39
1951	76.3	(NA)	39.73	1976	76.8	60	12.90
1952	75.4	(NA)	10.65	1977	78.2	68	12.36
1953	75.9	71	9.97	1978	76.8	69	25.05
1954	75.8	68	27.30	1979	77.0	68	16.93
1955	74.5	62	37.86				
1956	75.9	69	21.23	1980	77.5	69	26.90
1957	76.0	72	24.22	1981	77.1	72	13.41
1958	75.3	70	35.02	1982	76.9	56	34.92
1959	76.7	70	14.14	1983	77.2	64	5.03
				1984	78.1	71	17.08
1960	76.7	70	12.07	1985	76.9	69	17.38
1961	77.2	81	14.26	1986	78.3	77	13.93
1962	76.5	71	13.58	1987	77.9	73	23.53
1963	76.7	64	37.91	1988	78.5	75	16.47
1964	77.0	63	20.12	1989	77.5	79	27.52
1965 1/	76.1	74	42.78				
1966 1/	77.6	68	23.18	1990	77.6	77	19.84
1967 1/	77.6	58	34.34	1991	77.7	67	17.94
1968 1/	77.9	63	37.26	1992	77.8	(NA)	19.00
1969 1/	77.4	68	22.50	1993	77.1	88	5.84
				1994	78.8	89	15.59
1970 1/	78.2	72	15.49	1995	79.3	89	13.60
1971 1/	76.1	70	26.64	1996	78.6	(NA)	33.12
1972	76.2	65	26.94	1997	77.8	88	19.99
1973	77.2	63	14.24	1998	77.1	(NA)	4.52
1974	77.5	61	24.02	1999	76.9	(NA)	11.99

NA Not available.

1/ Site conditions produced distorted temperature measurements from 1965 to 1971.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii* (annual).

Table 5.36-- AVERAGE DAILY TEMPERATURE AND DAYS WITH MAXIMUM OF 90° OR HIGHER; FOR HONOLULU INTERNATIONAL AIRPORT: 1971 TO 1999

Year	Average daily maximum (°F)	Days 90° or higher	Year	Average daily maximum (°F)	Days 90° or higher
1971	82.7	-	1986	86.2	64
1972	83.2	3	1987	85.7	93
1973	84.4	10	1988	86.1	70
1974	85.0	25	1989	85.2	34
1975	83.6	1	1990	84.0	47
1976	84.1	9			
1977	85.2	16	1991	84.9	35
1978	84.2	13	1992	85.2	28
1979	84.7	51	1993	84.5	23
1980	84.6	22	1994	85.5	85
			1995	86.8	116
1981	84.6	9	1996	84.0	69
1982	83.5	27	1997	85.1	50
1983	85.1	44	1998	83.7	-
1984	85.5	63	1999	83.2	-
1985	84.6	53			

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii* (annual).

**Table 5.37-- CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT:
ANNUALLY, 1989 TO 1999**

Year	Average temperature (°F)			Extreme temp. (°F)		Precipitation (inches)
	Annual	Coolest month	Warmest month	Lowest	Highest	
1989	77.5	72.9	81.9	56	92	27.52
1990	77.6	71.5	82.3	57	93	19.84
1991	77.7	72.4	82.4	55	93	17.94
1992	77.8	72.9	82.2	58	92	19.00
1993	77.1	70.9	81.3	54	93	5.84
1994	78.8	72.0	84.3	56	95	15.59
1995	79.3	73.4	83.4	56	94	13.60
1996	78.6	74.0	82.8	56	93	33.12
1997	77.8	72.3	82.7	57	94	19.99
1998	77.1	72.5	81.1	53	89	4.52
1999	76.9	73.3	80.8	60	89	11.99

Year	Relative humidity (percent)		Wind speed (miles/hour)		Percent of possible sunshine	Days with precipitation .01 inch or more
	8 a.m.	2 p.m.	Annual average	Peak gust		
1989	72	55	10.5	41	79	82
1990	69	54	11.2	46	77	109
1991	69	53	10.0	39	67	86
1992	71	55	9.5	49	(NA)	98
1993	70	53	10.9	46	88	76
1994	72	55	11.9	51	89	80
1995	74	57	10.7	41	89	81
1996	73	56	9.6	40	(NA)	106
1997	80	57	10.0	41	88	105
1998	72	56	11.0	(NA)	(NA)	74
1999	73	57	11.0	(NA)	(NA)	94

NA Not available.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii* (annual).

Table 5.38-- CLIMATIC DATA FOR THE PERIOD OF RECORD

Subject	Date	Place	Magnitude
Long-term averages:			
Lowest monthly average minimum temp. (°F)	February	Mauna Kea summit	23.5
Lowest monthly average daily temp. (°F)	February	Mauna Kea summit	31.3
Highest monthly average maximum temp. (°F)	September	Kawaihae 1/	91.9
Highest monthly average daily temp. (°F)	September	Kawaihae 1/	80.8
Lowest average annual rainfall (inches)	...	Kawaihae	8.7
Highest average annual rainfall (inches)	...	Waialeale	444
Single events:			
Lowest temperature of record (°F)	Jan. 20, 1970	Mauna Kea summit 2/	1.4
Highest temperature of record (°F)	April 27, 1931	Pahala	100
Lowest annual rainfall of record (inches)	1953	Kawaihae	0.2
Highest annual rainfall of record (inches)	1982	Waialeale	666
Highest wind speed of record (m.p.h.)	Sept. 11, 1992	Makahuena Pt. 3/	143

1/ Puukohola Heiau National Historical Site, Kawaihae, Hawaii.

2/ Recorded by Dr. Alfred Woodcock 60 meters inside the Mauna Kea summit cone, at 6:50 a.m. The rim at that time had a temperature of 39°F.

3/ Makahuena Point Coast Guard Station, Poipu, Kauai.

Source: Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, Climatological Section, data supplied February 14, 1995. No updates as of September 22, 2000.

**Table 5.39-- RAINFALL AT SPECIFIED LOCATIONS: ANNUALLY,
1989 TO 1999**

[In inches]

Year	Hawaii				Maui		
	Hilo Airport	Lalamilo	Kona Village	Naalehu	Kahului Airport	Kihei	Lahaina
1989	166.71	(NA)	13.32	74.79	40.63	27.00	26.95
1990	211.22	23.54	19.80	89.83	35.20	19.17	19.84
1991	153.04	15.73	8.88	44.45	16.09	6.62	11.11
1992	119.89	12.72	9.90	40.57	16.98	11.03	9.73
1993	114.49	20.67	5.91	40.56	12.69	5.82	11.76
1994	182.81	11.87	4.62	63.34	13.93	5.61	8.02
1995	85.92	6.04	5.72	26.55	13.45	8.21	6.30
1996	120.21	25.35	24.70	59.07	31.00	22.32	22.81
1997	131.61	17.48	15.57	49.43	23.08	19.96	16.68
1998	108.78	8.86	1.37	17.62	6.76	4.47	1.86
1999	116.78	8.12	3.93	36.54	9.66	7.13	6.11

Year	Oahu				Kauai		
	Waikiki	University of Hawaii	Nuuanu Res. 4	Kane-ohe 1/	Koloa	Lihue Airport	Princeville
1989	(NA)	39.53	129.50	73.53	87.81	56.77	116.65
1990	26.15	40.66	137.81	60.48	73.27	39.37	86.44
1991	26.10	42.83	115.02	65.33	71.30	41.63	82.01
1992	(NA)	35.10	118.58	60.14	52.53	50.17	(NA)
1993	16.92	24.14	81.62	34.55	52.98	22.27	48.02
1994	20.16	33.68	125.48	52.36	60.73	32.99	72.15
1995	12.25	20.98	99.26	(NA)	56.76	46.57	86.94
1996	29.96	42.11	116.76	68.02	(NA)	56.14	85.53
1997	25.30	40.67	116.22	(NA)	42.02	48.02	81.57
1998	10.97	24.50	74.62	28.52	33.72	26.47	56.52
1999	19.09	26.55	89.60	30.76	40.25	33.19	67.15

NA Not available.

1/ Revised.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Climatological Data, Annual Summary, Hawaii and Pacific* (annual); Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records; Hawaii State Climatology Office, Department of Meteorology, University of Hawaii, records.

Table 5.40-- MAJOR HURRICANES: 1950 TO 1999

Hurricane name	Date 1/	Islands most affected	Maximum recorded winds ashore (m.p.h.)		Deaths	Property damage (mil. dol.)
			Sustained	Peak gusts		
Hiki	Aug. 15-17, 1950	Kauai	68	(NA)	1	0.2
Della	Sept. 4, 1957	French Frigate Shoals	82	109	-	Minor
Nina	Dec. 1-2, 1957	Kauai	(NA)	92	1	0.1
Dot	Aug. 6, 1959	Kauai	81	103	-	5.5+
Fico	July 18-20, 1978	Hawaii	(NA)	58+	-	0.2
Iwa	Nov. 23, 1982	Kauai, Oahu	65	117	1	234.0
Estelle	July 22, 1986	Maui, Hawaii	(NA)	55	-	2.0
Iniki	Sept. 11, 1992	Kauai, Oahu	92	143	8	1,900

NA Not available.

1/ Period affecting the Hawaiian Islands.

Source: Samuel L. Shaw, *A History of Tropical Cyclones in the Central North Pacific and the Hawaiian Islands, 1832-1979* (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, September 1981); Hawaii State Department of Defense, Civil Defense Division, *Catalogue of Natural and Man-Caused Incidents and Disasters in the Hawaiian Islands* (December 1978); The Governor's Ad Hoc Committee on the Economic Impact of Hurricane Iwa, *Hurricane Iwa's Economic Impact on Hawaii* (January 1983); "The History of Hurricanes in Hawaii", *Honolulu Star-Bulletin*, July 18, 1983, p. A-5; "20-Foot Waves Hit Big Isle As Storm Brushes Coastline", *The Honolulu Advertiser*, July 23, 1986, pp. A1, A2; "Hawaii Hurricanes", *Honolulu Star-Bulletin*, August 4, 1988, p. A-8; Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, records. <http://www.nws.noaa.gov/pr/hnl/cphc/pages/summaries.html>. Updated as of August 28, 2000.

**Table 5.41-- TRADE WINDS, HIGH SURF, AND TEMPERATURES IN
HAWAIIAN WATERS, BY MONTHS**

Month	Trade wind frequency 1/ (percent)	Expected days of strong trade winds 2/	Highest surf 3/ (average number of days)		Water temperature 4/ (°F)	
			Flat or 1 foot	6 feet or more	Mean maximum	Mean minimum
Jan.	42	9	1	19	74.7	71.1
Feb.	55	7	1	16	75.6	70.3
March	61	10	1	12	76.5	71.8
April	74	10	3	7	77.7	73.0
May	86	7	8	3	79.5	74.7
June	91	7	15	-	81.1	77.7
July	95	10	16	-	81.1	78.3
Aug.	94	7	15	-	81.9	79.2
Sept.	83	4	10	2	81.9	78.4
Oct.	71	4	1	12	81.1	77.2
Nov.	64	8	-	19	79.3	74.5
Dec.	57	9	-	20	75.9	71.4
Annual	73	92	71	110	78.6	74.8

1/ Mean monthly frequency of trade winds in Hawaiian waters.

2/ Expected number of hazardous days in Hawaiian waters due to strong trade winds.

3/ Observations at Sunset Beach, Oahu. Annual averages were: flat or 1 foot, 71 days; 2-5 feet, 184 days; 6-10 feet, 71 days; 11-15 feet, 26 days; 16 feet or higher, 13 days.

4/ Observations at Kaneohe, Oahu. The mean ranged from 73.0 in January and February to 80.2 in August. Absolute maximums and minimums were respectively 84 (in July, August, and October) and 68 (December and February).

Source: Paul Haraguchi, *Weather in Hawaiian Waters* (Honolulu: Pacific Weather, Inc., 1979), pp. 14, 22, 56, and 74; Hawaii State Department of Land and Natural Resources, Commission on Water Resource Management, data provided February 14, 1995. No updates as of September 22, 2000.

Table 5.42-- AVERAGE WATER TEMPERATURES AT WAIKIKI BEACH

[In Fahrenheit degrees]

Month	Morning	Afternoon
March	75	77
August	77	82

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary With Comparative Data, Honolulu, Hawaii, 1983*.

**Table 5.43-- SUNRISE, SUNSET, AND HOURS OF DAYLIGHT AT
SELECTED LOCATIONS, AT BEGINNING OF EACH SEASON: 2000**

[Hawaiian Standard Time]

Subject	Hilo	Kahului	Honolulu	Lihue
Sunrise (a.m.):				
March 20	6:24	6:29	6:35	6:41
June 21	5:43	5:46	5:50	5:55
Sept. 22	6:09	6:15	6:20	6:26
Dec. 21	6:51	6:58	7:05	7:12
Sunset (p.m.):				
March 20	6:32	6:37	6:43	6:49
June 21	7:02	7:10	7:16	7:24
Sept. 22	6:16	6:22	6:27	6:33
Dec. 21	5:47	5:50	5:55	6:00
Hours of daylight:				
March 20	12:08	12:08	12:08	12:08
June 21	13:19	13:24	13:26	13:29
Sept. 22	12:07	12:07	12:07	12:07
Dec. 21	10:56	10:52	10:50	10:48

Source: U.S. Naval Observatory, Tables of Sunrise and Sunset <<http://aa.usno.navy.mil/AA/data/>>.

**Table 5.44-- SUNRISE, SUNSET, AND HOURS OF DAYLIGHT AT
SELECTED LOCATIONS, AT BEGINNING OF EACH SEASON: 2001**

[Hawaiian Standard Time]

Subject	Hilo	Kahului	Honolulu	Lihue
Sunrise (a.m.):				
March 20	6:24	6:30	6:35	6:41
June 20	5:43	5:46	5:50	5:55
Sept. 22	6:09	6:15	6:20	6:26
Dec. 21	6:50	6:58	7:05	7:12
Sunset (p.m.):				
March 20	6:31	6:37	6:43	6:49
June 20	7:02	7:10	7:16	7:24
Sept. 22	6:16	6:22	6:27	6:33
Dec. 21	5:47	5:50	5:55	6:00
Hours of daylight:				
March 20	12:07	12:07	12:08	12:08
June 20	13:19	13:24	13:26	13:29
Sept. 22	12:07	12:07	12:07	12:07
Dec. 21	10:57	10:52	10:50	10:48

Source: U.S. Naval Observatory, Tables of Sunrise and Sunset <<http://aa.usno.navy.mil/AA/data/>>.

**Table 5.45-- "LAHAINA" (SHADOWLESS) NOONS FOR SELECTED
LOCATIONS: 1999 and 2000**

[Lahaina (or shadowless) noons occur when the sun is directly overhead at a specified location]

Location	Lahaina Noon	
	May	July
Honolulu:		
1999	27	16
2000	26	15
Time	12:28 p.m.	12:37 p.m.
Kahului:		
1999	24	19
2000	24	18
Time	12:22 p.m.	12:31 p.m.
Lihue:		
1999	31	11
2000	31	11
Time	12:23 p.m.	12:31 p.m.
Hilo:		
1999	19	24
2000	18	24
Time	12:17 p.m.	12:27 p.m.

Source: Bishop Museum Planetarium, <http://www.bishop.hawaii.org/bishop/planet/lahainanoon.html>.

**Table 5.46-- HAWAII AUDUBON SOCIETY BIRD COUNTS OF THE
HONOLULU AREA: 1996 TO 1999**

[Counts are made in late December, in a circle, 15 miles in diameter, centered near Nuuanu Pali]

Species	1996	1997	1998	1999
All species:				
Species	46	57	51	49
Individual birds	9,781	17,836	17,005	17,343
Endemic species: 1/				
'Apapane	6	16	9	43
Hawaiian Coot 2/	62	58	76	1
Hawaiian Stilt 2/	155	148	168	151
Oahu 'Amakihi	34	38	20	38
Hawaiian Moorhen 2/	4	8	9	6/ CW
Oahu 'Elepaio	13	4	10	13
Indigenous species: 3/				
Great Frigatebird	111	23	44	9
Red-footed Booby	1,246	125	1,221	969
Alien species: 4/				
Cattle Egret	231	40	178	172
Common Myna	1,146	2,136	2,474	1,732
Common Waxbill	622	1,117	408	713
House Sparrow	244	480	455	463
Japanese White-eye	303	547	403	95
Java Sparrow	396	1,754	1,525	2,515
Red-vented Bulbul	710	1,743	1,406	1,543
Rock Dove	239	304	302	305
Spotted Dove	703	1,239	1,295	1,238
Zebra (Barred) Dove	1,424	3,505	3,690	3,956
Visitor species: 5/				
Pacific Golden-Plover	763	1,351	1,268	894
Ruddy Turnstone	340	288	287	256

1/ Birds peculiar to Hawaii, and found nowhere else.

2/ Endangered species.

3/ Native to Hawaii, but also found elsewhere.

4/ Formerly termed "introduced". Includes accidental escapes from captivity.

5/ Formerly termed "migratory". Includes stragglers and seasonal migrants.

6/ Seen in count circle during Count Week [3 days before count day and 3 days after] but not found on count day.

Source: Hawaii Audubon Society, 'Elepaio (monthly), and records.

Table 5.47-- HAWAII AUDUBON SOCIETY BIRD COUNTS OF THE HONOLULU AREA, BY TYPE OF SPECIES: 1997 TO 1999

[Counts are made in late December. Annual changes reflect differences in numbers of bird counters and counting time in the field, as well as changes in bird populations. Totals by species are also affected by the types of habitats studied]

Type of species	Number of species			Number of individuals		
	1997	1998	1999	1997	1998	1999
All species	57	51	49	17,836	17,005	17,343
Endemic	7	7	8	281	306	329
Indigenous	4	9	7	171	1,313	1,038
Alien	34	27	30	15,695	13,761	14,762
Visitor	12	8	4	1,689	1,625	1,214

Source: Hawaii Audubon Society, records.

**Table 5.48-- TREES ALONG STREETS OR IN PARKS UNDER THE
JURISDICTION OF THE CITY AND COUNTY OF HONOLULU: 1994 TO 1999**

[As of June 30]

Location	1994	1995	1996	1997	1998	1999
Along City and County streets and highways 1/	131,817	132,286	134,270	135,626	136,982	138,352
In City and County parks	99,412	100,377	101,063	102,083	103,103	104,134

1/ Excludes Federal, State, and private thoroughfares.

Source: City and County of Honolulu, Department of Parks and Recreation, records.

Table 5.49-- ESTIMATED NUMBER OF SPECIES IN HAWAII: 1996 TO 1998

[Excludes viruses and bacteria]

Category	Species		
	1996	1997	1998
Total in Hawaii and surrounding waters	22,077	22,462	23,187
Endemic to Hawaii	8,805	8,864	9,176
Nonindigenous protists, fungi, plants, and animals	4,573	4,598	4,831
Terrestrial	(NA)	(NA)	(NA)
Found in fresh water	(NA)	(NA)	(NA)
Marine-inhabiting	6,500	(NA)	(NA)

NA. Not available.

Source: A. Allen, S. E. Miller and G. M. Nishida, "Hawaii Biological Survey: a model for the Pacific Region", *Marine and Coastal Biodiversity in the Tropical Island Pacific Region*, Volume I (1995): 349-355, East-West Center and Pacific Science Association, Honolulu; L. G. Eldredge and S. E. Miller, "How many species are there in Hawaii?", *Bishop Museum Occasional Papers* 41 (1995): 3-18; L. G. Eldredge and S. E. Miller, "Numbers of Hawaiian species: Supplement 2, including a review of freshwater invertebrates", *Bishop Museum Occasional Papers* 48 (1997): 3-22; L. G. Eldredge and S. E. Miller, "Numbers of Hawaiian species: Supplement 3, with notes on fossil species", *Bishop Museum Occasional Papers* 55 (1998): 3-15; L. G. Eldredge, "Numbers of Hawaiian species: Supplement 4", *Bishop Museum Occasional Papers* 58 (1999): 72-78.

Table 5.50-- THREATENED AND ENDANGERED SPECIES, FOR THE UNITED STATES AND HAWAII: JULY 11, 2000

	United States	Hawaii
Total	1,256	310
Mammals	74	1
Birds	94	31
Snails	31	2
Insects	39	1
Arachnids	6	1
Crustaceans	21	1
Flowering plants	704	261
Ferns and allies	26	12
Others	261	-

Source: U.S. Fish and Wildlife Service, Division of Endangered Species, Threatened and Endangered Species System (TESS) <http://ecos.fws.gov/servlet/TESSSpeciesReport/type>.