

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.

The State consists of eight major islands and 124 minor islands with a total land area of 6,423 square miles and a general coastline of 750 miles. Honolulu is 214 miles from Hilo, 1,367 miles from Kure Atoll (the westernmost end of the State), 2,397 miles from San Francisco, and 4,829 miles from Washington, D.C. The highest peak in the State is Puu Wekiu on Mauna Kea, 13,796 feet above sea level; the longest stream is Kaukonahua Stream, Oahu, 33 miles in length; the most extensive lake or similar body is Kawainui Marsh, 1,000 acres; and the highest named waterfall is Kahiwa, Molokai, a 1,750-foot cascade. Various measures of air pollution, such as suspended particulate matter, indicate that Honolulu is one of the cleanest cities in the nation. The 159 major beaches and streams surveyed in 1992 were found to have enterococci levels per 100 ml. ranging from 0.6 to 233.1, and 82 percent were within EPA standards. More than 500 species, subspecies, and varieties of native fauna and flora have been proposed or accepted for inclusion on lists of endangered, threatened, or extinct organisms.

Climatically, Hawaii is marked by remarkably balmy temperatures and wide variations in rainfall. The all-time temperature range at Honolulu International Airport, for example, was from 53° to 94°F. Average precipitation, however, ranges from less than nine inches at Kawaihae to 444 inches atop Waialeale. The volcanic eruption that began in 1983 had produced more than 1.4 billion cubic meters of lava by February 1992. Hawaii's worst recorded earthquake (1868) attained 7.5 on the Richter scale by retrospective estimate, the highest tsunami wave (1946) reached 56 feet, and the most destructive hurricane (Iniki, 1992) gusted to 143 miles per hour. Water withdrawn for use in 1990 averaged 1.4 billion gallons per day, compared with 2.9 billion in 1980 and 2.8 billion in 1975.

Important sources of data include the U.S. Geological Survey, National Ocean Survey, National Weather Service, U.S. Bureau of the Census Geography Division, the Division of Water Resource Management of the State Department of Land and Natural Resources, the State Department of Health, and the University of Hawaii Institute of Geophysics. Detailed information is given in *Atlas of Hawaii*, 2nd edition, published by the University of Hawaii Press in 1983. National data are reported in *Statistical Abstract of the United States: 1993*, Section 6.

Table 5.1-- 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
Hong Kong.....	5,541	4,815	8,915
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
North and South American locations:			
Anchorage, Alaska	2,781	2,417	4,475
Cape Horn, Chile	7,457	6,480	11,998

Continued on next page.

Table 5.1-- GREAT CIRCLE DISTANCES BETWEEN SPECIFIED PLACES -- Con.

Places	Statute miles	Nautical miles	Kilometers
DISTANCES FROM HONOLULU INT. AIRPORT--Con.			
North and South American locations, con.:			
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.

**Table 5.2-- TIME DIFFERENTIALS BETWEEN HONOLULU AND
SELECTED CITIES: 1993**

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

Source: Hawaiian Telephone Company, *Oahu Telephone Book 1992-1993*, p. 38; consulates; airlines.

Table 5.3-- WIDTHS AND DEPTHS OF CHANNELS

Channel <u>1/</u>	Width <u>2/</u>		Depth <u>3/</u>	
	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-Maroo Reef	155.5	250.3	12,300	3,749
Maroo 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 5.4-- GENERAL COASTLINE AND TIDAL SHORELINE OF COUNTIES AND ISLANDS

County and island	General coastline <u>1/</u>		Tidal shoreline <u>2/</u>	
	Statute miles	Kilometers <u>3/</u>	Statute miles	Kilometers <u>3/</u>
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: <u>4/</u>				
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 <u>5/</u> ...	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 5.5-- 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, National Oceanic and Atmospheric Administration, information supplied September 15, 1978.

Table 5.6-- 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 <u>1/</u>	35.9	4.4	3.6	-	19.0	8.9
Territorial water <u>2/</u> .	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 <u>1/</u>	92.9	11.5	9.3	-	49.2	22.9
Territorial water <u>2/</u> .	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 <u>1/</u>	22,976	2,816	-	2,304	12,160	5,696
Territorial water <u>2/</u> .	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 5.7-- LAND AREA OF ISLANDS: 1990

Island	Square miles <u>1/</u>	Square kilometers	Acres <u>1/</u>
State total	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 <u>2/</u>	3.108	8.049	1,989
Niihoa	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 <u>3/</u>			
Johnston Atoll <u>4/</u>	0.5	1.3	320
Kingman Reef <u>4/</u>	3.0	7.8	1,920
Midway Islands.....	0.55	1.42	352
Palmyra Atoll <u>4/</u>	4.0	10.4	2,560

1/ Areas in square miles and acres were calculated directly from measurements in .001 square kilometer 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.

4/ 1980 measurement.

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; Summary Tape File 1B; and letter from Geography Division, March 30, 1992.

Table 5.8-- 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 1.5.

^{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 5.9-- MAJOR NAMED WATERFALLS, BY ISLANDS: 1994

Island	Waterfall	Height (feet)		Horizontal distance (feet)
		Sheer drop	Cascade	
Hawaii.....	Kaluahine .....	...	620	400
	Akaka	442	...	...
Maui.....	Honokohau.....	...	1,120	500
	Kahiwa .....	...	1,750	1,000
Molokai.....	Papalaua.....	...	1,200	500
	Kaliuwaa (Sacred).....	^{1/} 80	1,520	3,000
Oahu.....	Waipoo (2 falls).....	...	800	600
	Awini.....	...	480	500

^{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, Division of Water Resource Management, records.

Table 5.10-- ELEVATIONS OF MAJOR SUMMITS

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

Island and summit	Feet	Meters
Hawaii:		
Mauna Kea <u>1</u> /	13,796	4,205
Mauna Loa <u>2</u> /	13,679	4,169
Hualalai.....	8,271	2,521
Kaumu o Kaleihoohe	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 5.10-- 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 *1991 Guinness Book of World Records* (p. 142), "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 33,476 ft., of which 13,796 ft. are above sea level."

^{2/} *Guinness* (pp. 142-143) describes Mauna Loa as having "dimensions, but not height, [which] exceed those of Mt. Everest ... The axes of its elliptical base, 16,322 ft. below sea level, have been estimated at 74 miles and 53 miles."

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 5.11-- MAJOR STREAMS, BY ISLANDS: 1994

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): <u>1/</u>		
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 <u>2/</u> (million gal./day):		
Hawaii.....	Wailuku River	250
Maui.....	Iao Stream.....	43
Molokai	Wailau Stream.....	30
Oahu.....	Waikele Stream.....	<u>3/</u> 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, Division of Water Resource Management, records.

Table 5.12-- LAKES AND LAKE-LIKE WATERS, BY ISLANDS: 1994

Island and lake	Type	Elevation (feet)	Area ^{1/} (acres)	Maximum depth (feet)
Hawaii:				
Green Lake	Lake	3	2	20
Lake Waiiau ^{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
Kaelepuu 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, Division of Water Resource Management, May 18, 1994.

Table 5.13-- 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
The State .....	...	...	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
Island	Percent of area with elevation --		Approximate mean altitude (feet)	Percent of area with slope --	
	Less than 500 feet	2,000 feet or more		Less than 10 percent	20 percent or more
The State	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	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	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 World Records* (1991 edition, p. 148) as "the highest sea cliffs yet pinpointed anywhere in the world."

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

Table 5.14-- VOLCANIC ERUPTIONS: 1969 TO 1993

[Complete through December 31, 1993. 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]

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	867	ER	940	12.5	176.7
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. 4	4.3	455	ER	940	35.1	119.6
1973: May 5	-	<1	ER	1,000-980	0.3	1.2
Nov. 10	-	30	ER	980-870	1.0	2.7
Dec. 12	0.1	203	ER	940	8.1	28.7
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	<1.0	3.0
1983: Jan. 3 ^{2/}	3.3	4,015	ER	780-650	83.4	1,436

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

^{2/} Still in progress, December 31, 1993. As of that time, there had been 53 separate episodes. These had destroyed 181 housing units and added 491 acres 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, as updated by the staff of the Hawaiian Volcano Observatory.

**Table 5.15-- EARTHQUAKES OF MAGNITUDE 5 OR GREATER:
1975 TO 1993**

[Complete to January 26, 1993]

Date and time (HST)	Location	Magnitude (Richter scale)
1975: Jan. 2, 3:27 AM.....	Near Pahala, Hawaii	5.0
Nov. 29, 3:35 AM	Puna, Hawaii	5.7
Nov. 29, 4:47 AM	Puna, Hawaii	7.2
1976: Feb. 20, 7:51 PM	Between Maui and Hawaii.....	5.1
1977: Jan. 22, 12:36 PM.....	100 miles S. of Kauai	5.1
Apr. 20, 6:49 PM	Hamakua, Hawaii	5.0
Jun. 5, 11:42 PM.....	Puna, Hawaii	5.1
1979: Mar. 29, 11:06 PM	40 miles S.W. of Oahu	5.5
Sept. 21, 9:59 PM	Puna, Hawaii	5.5
1981: Mar. 5, 4:09 AM	Molokai area.....	5.3
Nov. 10, 3:02 AM	Kilauea, Hawaii.....	5.3
1982: Jan. 21, 11:52 AM.....	Mauna Loa, Hawaii	5.5
Jan. 21, 12:29 PM.....	Mauna Loa, Hawaii	5.5
May 14, 6:26 AM.....	Off Kawaihae, Hawaii.....	5.0
1983: Mar. 20, 5:18 PM	Off Kalapana, Hawaii	5.0
Sept. 9, 6:30 AM	Off Kalapana, Hawaii	5.4
Nov. 16, 6:13 AM	S.E. flank of Mauna Loa.....	6.7
1984: Jun. 8, 5:34 PM.....	80 miles S. of Honolulu	5.3
1986: Apr. 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
1988: March 24, 2:30 PM.....	30 miles S. of Kahoolawe.....	5.0
March 27, 5:33 PM.....	30 miles S. of Kahoolawe.....	5.5
June 7, 12:49 AM.....	S. flank of Kilauea	5.0
July 3, 7:38 PM	Near Pahala	5.3
July 22, 10:29 AM	Near French Frigate Shoals	5.0
1989: June 25, 5:27 PM.....	Kalapana area.....	6.1
Dec. 27, 11:13 PM	Kilauea East Rift Zone	5.1
1990: Aug. 8, 4:06 PM	Kilauea East Rift Zone	5.4
1991: May 7, 10:21 PM.....	13 miles W. of Kailua-Kona	5.3
1993: Jan. 26, 5:24 AM.....	Near Pahala, Hawaii	5.0

Source: Hawaii Institute of Geophysics, records; Hawaii Volcano Observatory Summaries; U.S. Geological Survey, National Earthquake Information Service; *Honolulu Advertiser*, January 27, 1993. Data provided by Professor Augustine S. Furumoto, Hawaii Institute of Geophysics, University of Hawaii at Manoa, January 14, 1993.

**Table 5.16-- TSUNAMIS WITH RUN-UP OF 2 METERS (6.6 FEET) OR MORE:
1946 TO 1993**

[Complete to January 13, 1993]

Date	Maximum height in Hawaii		Deaths in Hawaii	Damage in Hawaii (dollars)
	Meters	Feet		
1946: April 1	17.0	55.8	159	26,000,000
1952: Nov. 4	6.1	20.0	-	1,000,000
1957: March 9	16.0	52.5	-	5,000,000
1960: May 22	10.5	34.5	61	23,000,000
1964: March 27	4.8	15.7	-	67,590
1975: Nov. 29	14.6	48.0	2	1,500,000

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, Environmental Center, June 1987), p. 39; Hawaii Institute of Geophysics, records.

Table 5.17-- 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, Division of Water Resource Management, records.

Table 5.18-- FRESH WATER USE, BY TYPE, BY ISLANDS: 1990

[Million gallons per day]

Use	State total	Hawaii	Maui	Lanai	Molokai	Oahu	Kauai	Niihau
Total	1,443.74	192.69	516.59	2.90	10.97	350.56	369.97	0.06
Ground water	556.71	92.21	99.04	2.90	3.74	313.29	45.47	0.06
Domestic.....	134.45	18.36	19.32	0.84	0.79	86.02	9.09	0.03
Agricultural.....	195.42	9.31	41.80	1.96	2.36	120.67	19.29	0.03
Industrial	29.18	3.95	1.85	-	-	22.90	0.48	-
Thermoelectric...	95.72	57.13	26.96	-	-	0.65	10.98	-
Commercial	101.94	3.46	9.11	0.10	0.59	83.05	5.63	-
Surface water.....	887.03	100.48	417.55	-	7.23	37.27	324.50	-
Domestic.....	1.70	0.51	0.80	-	0.12	-	0.27	-
Agricultural.....	598.17	13.52	316.10	-	7.11	37.27	224.17	-
Industrial	22.84	16.50	-	-	-	-	6.34	-
Thermoelectric...	0.05	-	0.05	-	-	-	-	-
Commercial	0.60	-	0.60	-	-	-	-	-
Hydroelectric.....	263.67	69.95	100.00	-	-	-	93.72	-

Source: Data compiled by the U.S. Geological Survey and provided by the Hawaii State Department of Land and Natural Resources, Division of Water Resource Management, May 18, 1994.

Table 5.19-- WATER SERVICES AND CONSUMPTION, FOR COUNTY WATERWORKS: 1992 AND 1993

Geographic area	Number of services, June 30		Consumption (million gallons) ^{1/}	
	1992	1993	1992	1993
State total	216,001	(NA)	74,118	(NA)
City and County of Honolulu.....	143,615	145,626	51,241	51,033
Honolulu ^{2/}	60,564	60,691	26,734	26,357
Rest of Oahu.....	83,051	84,935	24,507	24,676
Hawaii County	31,564	31,982	8,025	7,937
Kauai County	15,414	15,466	4,453	4,056
Maui County	25,408	(NA)	10,399	(NA)
Maui	23,957	(NA)	10,071	(NA)
Molokai.....	1,451	(NA)	328	(NA)

NA Not available.

^{1/} Year ended June 30.

^{2/} Maunaloa to Moanalua.

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

**Table 5.20-- ENVIRONMENTAL QUALITY INDEXES AND RANKS:
1988-1989**

Measure	Median State	Hawaii	Hawaii rank ^{1/}
Air pollution standard index, 1989 ^{2/}	100	44	4
Toxic chemicals released, 1988 (pounds per person) ^{2/}	20	3	2
Unsafe drinking water, 1988 (percent of population) ^{3/}	9	3	7

^{1/} States were ranked from 1 (best) to 50 (worst).

^{2/} EPA data.

^{3/} Percent of population served by community drinking systems not in compliance with Safe Drinking Water Act of 1974 and 1986, from National Wildlife Federation.

Source: Northwestern National Life Insurance Company, *The NWNL State Health Rankings, 1991 Edition*, pp. 46-48.

Table 5.21-- POLLUTION ABATEMENT CAPITAL EXPENDITURES AND OPERATING COSTS: 1988 TO 1992

[Millions of dollars. Statistics cover manufacturing establishments with 20 employees or more]

Subject and year	Total, including nonmedia	Media				Nonmedia and other
		Total	Air	Water	Solid/ contained waste	
Capital expenditures:						
1988	(NA)	7.9	3.5	(D)	(D)	(NA)
1989	(NA)	(D)	(D)	(D)	(D)	(NA)
1990	(NA)	23.2	12.6	(D)	(D)	(NA)
1991	(NA)	4.0	1.8	(D)	(D)	(NA)
1992	2.9	2.8	.5	2.3	-	(Z)
Operating costs:						
1988	(NA)	16.2	4.8	5.9	5.5	(NA)
1989	(NA)	7.0	3.2	2.5	1.3	(NA)
1990	(NA)	12.0	3.5	(D)	(D)	(NA)
1991	(NA)	15.8	(D)	9.0	(D)	(NA)
1992	16.2	12.8	3.3	4.6	4.9	3.4

D Withheld to avoid disclosing operations of individual companies.

Z Less than half the unit shown.

NA Not available.

Source: U.S. Bureau of the Census, "Pollution Abatement Costs and Expenditures, 1992," *Current Industrial Reports*, MA200(92)-1, March 1994, table 2.

**Table 5.22-- WATER QUALITY AT PUBLIC BEACHES, BY ISLANDS:
1992 AND 1993**

Island	Number of locations	Number of samples	Enterococci density ^{1/}			
			Lowest ^{2/}	Highest ^{3/}	Number over 7	Mean ^{4/}
1992						
State total	159	3,252	0.6	233.1	28	3.0
Hawaii.....	45	596	0.8	64.5	10	3.1
Hilo Shoreline	22	231	1.0	64.5	8	5.8
Kona Shoreline..	23	365	0.8	13.1	2	2.0
Maui.....	31	320	0.7	12.7	1	1.4
Lanai.....	2	12	1.1	1.5	-	1.3
Molokai.....	2	14	4.5	35.4	1	12.6
Oahu.....	52	2,008	0.6	233.1	10	3.2
Kauai	27	302	0.7	45.5	6	3.1
1993						
State total	157	2,554	0.7	126.0	25	3.1
Hawaii.....	39	504	1.1	71.8	5	2.7
Hilo Shoreline	16	159	2.0	71.8	3	3.6
Kona Shoreline..	23	358	1.1	17.8	2	2.3
Maui.....	31	349	1.0	14.7	2	2.1
Lanai.....	2	8	1.0	1.9	-	1.4
Molokai.....	2	4	21.9	50.8	2	33.4
Oahu.....	53	1,479	0.9	126.0	7	3.7
Kauai	30	197	0.7	101.8	4	2.4

^{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 1992 was that reported for two Oahu locations, the northern region of Kaneohe Bay and Mamala Bay (Sand Island Offshore). In 1993, the lowest average value was that reported for Breuncke Beach on Kauai.

^{3/} The highest average value in both 1992 and 1993 was that 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 5.23.-- WATER QUALITY AT SELECTED PUBLIC BEACHES:
1992 AND 1993**

Island and beach	Number of samples		Enterococci density ^{1/}	
	1992	1993	1992	1993
Hawaii:				
Hapuna Beach	16	13	1.1	1.6
Kahaluu Beach	21	23	2.2	1.6
Kealakekua Bay (curio stand)	14	10	0.8	2.2
Hilo Bay (Mooheau Park)	10	0	2.1	-
Spencer Beach Park	16	13	2.1	2.2
Maui:				
Kapalua (Fleming) Beach (north)	10	11	0.8	2.5
Kihei (north)	11	12	0.9	1.1
Makena Beach	11	11	1.0	1.5
Seven Pools	5	10	2.5	1.0
Sheraton Kaanapali (shoreline)	9	11	0.9	1.1
Lanai:				
Hulopoe Bay	6	4	1.1	1.0
Molokai:				
Kaunakakai Harbor	7	2	4.5	50.8
Oahu:				
Ala Moana Park (center)	15	24	3.6	2.0
Ewa Beach Park	49	40	1.8	2.5
Haleiwa Beach	35	23	3.8	2.5
Hanauma Bay	48	38	6.8	6.5
Kailua Beach Park	49	38	3.2	3.1
Kuhio Beach	46	39	11.3	9.4
Makaha Beach	48	40	1.2	1.7
Waimea Beach	47	39	1.5	3.3
Kauai:				
Anini Park Pavilion	13	7	4.6	1.6
Kalapaki Beach	12	7	7.5	4.9
Kekaha (Oomano Pt.)	10	7	1.1	1.0
Poipu Beach Pavilion	10	7	2.0	3.1
West of Lydgate Park (wading pool)	8	7	0.8	1.0

^{1/} See previous table, footnote 1.

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

**Table 5.24-- REFUSE AND SEWAGE STATISTICS FOR OAHU:
1983 TO 1993**

[Fiscal years]

Year	Tons of municipal solid waste delivered <u>1/</u>			Sewage treated <u>2/</u> (millions of gallons)
	Total	City and County refuse vehicles	Other vehicles	
1983	626,835	360,545	266,290	37,395
1984	611,386	297,215	314,171	38,283
1985	615,574	272,905	342,669	37,817
1986	681,874	375,847	306,027	37,608
1987	678,392	380,810	297,582	38,199
1988	739,820	403,528	336,292	39,757
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

Year	Sewage pumped <u>2/</u> (millions of gallons)	Miles of sewers <u>2/</u>	City and County pump stations	City and County treatment plants
1983	48,442	1,670	52	20
1984	48,320	1,691	51	18
1985	49,361	1,711	51	17
1986	48,559	1,736	55	17
1987	49,542	1,752	57	17
1988	51,713	1,769	59	17
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

1/ Excludes small landfill controlled by armed forces.

2/ Data limited to system maintained by the City and County of Honolulu Public Works Department.

Source: City and County of Honolulu, *Departmental and Agency Reports* (annual), and City Refuse Division, records.

Table 5.25-- LITTER ALONG OAHU HIGHWAYS: 1979 TO 1993

Measure	1979	1981	1985	1988	1993
Visible litter items per mile	1,381	1,672	1,038	892	521
Visible beer/soft drink containers per mile	144	80	49	26	28
Indiscriminate dumps per 1,000..... miles of driving	8.2	15.7	19.6	14.1	12.6
Abandoned vehicles per 1,000 miles of driving	4.9	23.6	57.4	6.8	2.1

Source: Daniel B. Syrek, *Hawaii Litter: 1993* (Sacramento: The Institute for Applied Research, for the Hawaii State Department of Health, Litter Control Office, August 1993).

Table 5.26-- AIR QUALITY IN DOWNTOWN HONOLULU: 1982 TO 1992

[Annual arithmetic means, in micrograms per cubic meter, for total suspended particulates and sulfur oxides. Sampling is conducted about 46 feet above ground on the roof of the State Health Department building, 1250 Punchbowl Street, Honolulu, Hawaii]

Year	Particulates	Sulfur oxides	Year	Particulates	Sulfur oxides
1982.....	29	11	1989.....	30	<5
1983.....	26	<5	1990.....	30	<5
1984.....	25	<5	1991.....	30	<5
1985.....	24	<5	1992.....	28	<5
1986.....	25	<5	Standards.....	60	80
1987.....	26	<5			
1988.....	26	<5			

Source: Hawaii State Department of Health, Clean Air Branch, data supplied May 20, 1993.

Table 5.27-- AIR QUALITY AT SPECIFIED LOCATIONS: 1992

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

Sampling station	Total suspended particulates ^{1/}			Sulfur dioxide		
	Annual range		Arithmetic average	Annual range		Arithmetic average
	Minimum	Maximum		Minimum	Maximum	
Oahu:						
Downtown Honolulu...	14	88	28	<5	<5	<5
Liliha	20	46	30	...	...	...
Pearl City	8	32	16	...	...	...
Kapolei.....	8	164	27*	...	...	...
Makaiwa .....	...	...	...	0	27	4
West Beach	7	43	15	...	...	...
Waimanalo.....	6	28	17	...	...	...
Maui:						
Lahaina.....	7	23	13	...	...	...
Kauai:						
Lihue.....	9	32	18	...	...	...

^{1/} Particulates data for all locations except Downtown Honolulu and Liliha from PM₁₀ samplers (measuring inhalable particulates of less than 10 micrograms).

Source: Hawaii State Department of Health, Clean Air Branch, data supplied May 20, 1993.

Table 5.28-- ATMOSPHERIC CARBON DIOXIDE MEASUREMENTS AT MAUNA LOA: ANNUAL MEAN VALUES, 1958 TO 1992

[Parts per million]

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

1/ Based on data for 8 months.

2/ Based on data for 9 months.

3/ Based on data for 11 months.

Source: National Oceanic and Atmospheric Administration, Geophysical Monitoring for Climatic Change, records; provided by Saul Price, National Weather Service, Pacific Region, Honolulu.

Table 5.29-- TEMPERATURES AND PRECIPITATION FOR SELECTED PLACES

Island and station	Ground elevation (feet)	Average temperature (°F.)		Extreme temperature of record (°F.)		Average annual precipitation (inches)
		Coollest month	Warmest month	Lowest	Highest	
Hawaii:						
Hilo Airport.....	30	71.2	75.9	53	94	128
Hawaii Volcanoes Nat. Park Hdq....	3,970	57.6	63.2	37	85	101
Naalehu	675	70.2	75.2	55	90	47
Kailua	30	72.1	77.3	54	93	25
Puako 1/.....	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 2/.....	13,796	31.3	42.5	11	66	20
Maui:						
Hana	120	71.3	76.8	50	90	69
Haleakala summit	10,025	42.6	50.0	14	73	44
Kihei 3/.....	85	70.9	78.4	49	98	13
Kahului Airport	40	71.5	79.2	48	96	20
Lahaina	45	71.5	78.0	52	93	15
Molokai:						
Kaunakakai	10	(NA)	(NA)	(NA)	(NA)	14
Molokai Airport.....	450	70.2	77.6	48	90	27
Lanai:						
Lanai City	1,620	65.8	72.8	46	88	37

Continued on next page.

Table 5.29-- TEMPERATURES AND PRECIPITATION FOR SELECTED PLACES -- Con.

Island and station	Ground elevation (feet)	Average temperature (°F.)		Extreme temperature of record (°F.)		Average annual precipitation (inches)
		Coolest month	Warmest month	Lowest	Highest	
Oahu:						
Honolulu International Airport	10	72.6	81.0	53	94	23
Waikiki (Honolulu Zoo).....	10	71.9	80.6	51	93	25
Manoa (Lyon Arboretum).....	500	69.4	75.2	(NA)	(NA)	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	71.3	79.1	50	90	44
Poipu (Makahuena Pt.).....	50	72.4	79.4	50	93	35
Kekaha.....	9	71.0	78.5	48	95	21
Kokee (Kanalohuluhulu)	3,600	54.9	65.5	31	83	70
Northwestern Hawaiian Islands:						
Midway.....	10	65.0	78.6	52	89	44

NA Not available.

1/ Temperature data are for Mahukona.

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

3/ Temperature data refer to Puunene Airport.

Source: Hawaii State Department of Land and Natural Resources, Division of Water Resource Management, data supplied September 27, 1993.

Table 5.30-- CLIMATIC NORMALS, MEANS, AND EXTREMES FOR HILO, KAHULUI, HONOLULU, AND LIHUE AIRPORTS

Subject	Hilo	Kahului	Honolulu	Lihue
Normal temperatures (°F.):				
Daily maximum	81.2	83.8	84.2	81.1
Daily minimum	65.9	67.2	69.7	69.3
Monthly: Coolest month	71.2	71.5	72.6	71.3
Warmest month	75.9	79.2	81.0	79.1
Annual	73.6	75.5	77.0	75.2
Extreme temperatures (°F.):				
Record highest	94	96	94	90
Record lowest	53	48	53	50
Normal degree days, base 65°F				
Heating	-	-	-	-
Cooling	3,134	3,851	4,389	3,758
Precipitation (inches):				
Normal	128.15	19.85	23.47	44.02
Maximum monthly	50.82	14.46	20.79	22.91
Minimum monthly	0.28	0.00	T	T
Relative humidity (percent):				
8 A.M.	80	75	72	78
2 P.M.	68	58	55	67
Wind speed (m.p.h.):				
Mean	7.2	12.8	11.3	12.3
Fastest observation, 1 minute ^{1/}	35	44	46	84
Percent of possible sunshine	41	67	69	57
Mean number of days:				
Clear	35.6	130.9	90.4	55.9
Partly cloudy	131.0	144.3	180.1	183.0
Cloudy	198.7	90.1	94.7	126.4
Precipitation .01 inch or more	278.3	100.3	98.4	200.4

T Trace amount.

^{1/} Kahului figure refers to fastest mile.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary with Comparative Data, 1993* for Hilo, Kahului, Honolulu, and Lihue.

Table 5.31-- MONTHLY AND ANNUAL CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT

Month	Normal temperature (°F)			Extreme temperature (°F)		Precipitation (inches)			
	Daily maximum	Daily minimum	Monthly	Record highest	Record lowest	Normal total	Maximum monthly	Minimum monthly	Maximum in 24 hours
January	79.9	65.3	72.6	87	53	3.79	14.74	0.18	6.72
February	80.4	65.3	72.9	88	53	2.72	13.68	0.06	6.88
March.....	81.4	67.3	74.4	88	55	3.48	20.79	0.01	17.07
April.....	82.7	68.7	75.7	89	57	1.49	8.92	0.01	4.21
May.....	84.8	70.2	77.5	93	60	1.21	7.23	0.05	3.44
June.....	86.2	71.9	79.1	92	65	0.49	2.46	T	2.28
July	87.1	73.1	80.1	92	66	0.54	2.33	0.03	2.20
August.....	88.3	73.6	81.0	93	67	0.60	3.08	T	2.35
September	88.2	72.9	80.6	94	66	0.62	2.74	0.05	1.40
October.....	86.7	72.2	79.5	94	61	1.88	11.15	0.11	7.57
November.....	83.9	69.2	76.6	93	57	3.22	14.72	0.03	9.15
December.....	81.4	66.5	74.0	89	54	3.43	17.29	0.06	8.25
Annual.....	84.2	69.7	77.0	94	53	23.47	20.79	T	17.07

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Table 5.31-- MONTHLY AND ANNUAL CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT -- Con.

Month	Relative humidity (percent)		Wind (miles/hour)		Percent of possible sunshine	Mean sky cover, sunrise to sunset <u>2/</u>	Mean number of days		
	8 A.M.	2 P.M.	Mean speed	Fastest obs. <u>1/</u>			Clear	Cloudy	Precip. .01 inch or more
January	81	61	9.5	32	64	5.4	9.4	8.5	9.5
February	78	59	10.2	35	66	5.5	8.2	7.7	9.2
March	73	57	11.4	30	70	5.8	7.5	9.4	8.8
April	69	55	11.8	31	69	6.1	5.7	9.9	8.8
May	67	53	11.8	30	70	5.9	6.5	9.1	7.3
June	66	52	12.7	26	72	5.5	6.4	6.4	5.8
July	67	51	13.2	28	75	5.3	7.6	5.2	7.3
August	68	52	12.8	28	76	5.2	8.2	6.0	6.3
September	68	52	11.2	38	76	5.2	8.2	5.7	7.0
October	70	55	10.5	25	69	5.7	7.4	8.5	8.8
November	75	58	10.7	46	62	5.7	7.2	9.1	9.2
December	79	60	10.4	33	61	5.6	8.2	9.2	10.3
Annual	72	55	11.3	46	69	5.6	90.4	94.7	98.4

T Trace amount.

1/ Fastest observation, 1 minute, during period of record.

2/ Sky cover is expressed in a range of 0 for no clouds or obscuring phenomena to 10 for complete sky cover.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, *Local Climatological Data, Annual Summary With Comparative Data, Honolulu, 1993.*

**Table 5.32-- CLIMATIC DATA FOR HONOLULU INTERNATIONAL AIRPORT:
ANNUALLY, 1983 TO 1993**

Year	Average temperature (°F)			Extreme temp. (°F)		Precipitation (inches)
	Annual	Coolest month	Warmest month	Lowest	Highest	
1983.....	77.2	71.3	82.4	53	92	5.03
1984.....	78.1	74.1	81.7	57	94	17.08
1985.....	76.9	71.4	81.9	54	93	17.38
1986.....	78.3	72.6	82.9	56	94	13.93
1987.....	77.9	71.2	82.9	55	94	23.53
1988.....	78.5	73.1	82.1	57	94	16.47
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
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		
1983.....	75	52	9.8	(NA)	64	78
1984.....	72	53	10.2	40	71	81
1985.....	72	55	10.6	46	69	87
1986.....	74	55	10.1	41	77	88
1987.....	70	54	9.9	41	73	99
1988.....	71	53	9.8	39	75	88
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

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 5.33-- 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 <u>1/</u>	91.9
Highest monthly average daily temp. (°F.).....	September.....	Kawaihae <u>1/</u>	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 <u>2/</u>	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. <u>3/</u>	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, Division of Water Resource Management, Climatological Section, data supplied September 27, 1993.

**Table 5.34-- RAINFALL AT SPECIFIED LOCATIONS: ANNUALLY,
1982 TO 1992**

[In inches]

Year	Hawaii				Maui		
	Hilo Airport	Waimea 1/	Kona Village	Naalehu	Kahului Airport	Kihei	Lahaina
1982	170.36	56.29	26.88	65.75	34.04	29.11	34.36
1983	68.09	12.95	8.51	21.08	13.05	8.60	9.70
1984	100.08	8.87	8.15	39.51	8.56	5.64	6.30
1985	112.96	16.58	8.60	48.74	20.00	13.86	13.48
1986	171.03	34.67	12.41	64.55	18.39	7.25	7.38
1987	142.41	19.43	10.24	49.13	24.31	14.03	19.72
1988	140.19	12.52	11.70	38.21	26.79	17.03	14.91
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
Year	Oahu				Kauai		
	Waikiki	University of Hawaii	Nuuanu Res. 4	Kane- ohe 2/	Koloa	Lihue Airport	Prince- ville
1982	39.96	57.98	168.16	120.40	96.75	74.40	241.22
1983	9.80	19.77	74.32	43.49	50.69	16.40	46.93
1984	19.35	33.13	71.32	(NA)	48.82	30.12	71.58
1985	25.61	42.19	101.20	(NA)	48.70	28.91	55.22
1986	22.39	32.39	120.60	77.66	64.64	27.99	90.28
1987	27.56	46.52	134.29	77.79	72.53	42.95	94.61
1988	24.50	(NA)	124.42	81.10	63.23	43.06	77.10
1989	(NA)	39.53	129.50	88.20	87.81	56.77	116.65
1990	26.15	40.66	137.81	131.69	73.27	39.37	86.44
1991	26.10	42.83	115.02	90.59	71.30	41.63	82.01
1992	(NA)	35.10	118.58	(NA)	52.53	50.17	(NA)

NA Not available.

1/ Lalamilo Field Office.

2/ Hawaii State Hospital. The August 1990 value is for a comparable station (Pali Golf Course).

Source: U.S. Department of Commerce, National Climatic Data Center, *Climatological Data, Annual Summary, Hawaii and Pacific* (annual); and Hawaii State Department of Land and Natural Resources, Division of Water Resource Management, records.

Table 5.35-- MAJOR HURRICANES: 1950 TO 1993

[Complete to September 27, 1993]

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 Frig. 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 No 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," *Honolulu Advertiser*, July 23, 1986, pp. A-1, A-2; "Hawaii Hurricanes," *Honolulu Star-Bulletin*, August 4, 1988, p. A-8; Hawaii State Department of Land and Natural Resources, Division of Water Resource Management, data provided September 27, 1993.

Table 5.36-- TRADE WINDS, HIGH SURF, AND TEMPERATURES IN HAWAIIAN WATERS, BY MONTHS

Month	Trade wind frequency <u>1/</u> (percent)	Expected days of strong trade winds <u>2/</u>	Highest surf <u>3/</u> (average number of days)		Water temperature <u>4/</u> (°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
Ann.	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 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), pages 14, 22, 56, and 74; Hawaii State Department of Land and Natural Resources, Division of Water Resource Management, data provided September 27, 1993.

Table 5.37-- 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 5.38-- SUNRISE, SUNSET, AND HOURS OF DAYLIGHT AT SELECTED LOCATIONS, AT BEGINNING OF EACH SEASON

[Hawaiian Standard Time]

Subject	Hilo	Kahului	Honolulu	Lihue	Barking Sands
Sunrise (A.M.):					
March 21	6:24	6:29	6:35	6:41	6:42
June 21.....	5:42	5:45	5:50	5:55	5:56
Sept. 23.....	6:09	6:15	6:21	6:26	6:28
Dec. 22	6:51	6:58	7:05	7:12	7:14
Sunset (P.M.):					
March 21	6:32	6:37	6:43	6:49	6:51
June 21.....	7:02	7:10	7:16	7:23	7:25
Sept. 23.....	6:16	6:21	6:27	6:33	6:35
Dec. 22	5:47	5:50	5:55	6:00	6:01
Hours of daylight:					
March 21	12:08	12:08	12:08	12:08	12:09
June 21.....	13:20	13:25	13:26	13:28	13:29
Sept. 23.....	12:07	12:06	12:06	12:07	12:07
Dec. 22	10:56	10:52	10:50	10:48	10:47

Source: Nautical Almanac Office, U.S. Naval Observatory, Tables of Sunrise and Sunset, No. 1083 and 1084, and records. Data provided by Saul Price, Staff Meteorologist, National Weather Service, Pacific Region.

**Table 5.39-- HAWAII AUDUBON SOCIETY BIRD COUNTS OF THE
HONOLULU AREA: 1990 TO 1993**

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

Species	1990	1991	1992	1993
All species:				
Species.....	48	46	48	45
Individual birds	18,705	17,864	18,779	22,598
Endemic species: <u>1/</u>				
'Apapane	4	158	57	145
Hawaiian Coot	8	15	10	81
Hawaiian Stilt.....	143	99	77	137
Oahu 'Amakihi	151	66	79	136
Indigenous species: <u>2/</u>				
Great Frigatebird	82	30	50	126
Red-footed Booby	363	472	287	916
Alien species: <u>3/</u>				
Cattle Egret.....	378	486	202	258
Common Mya	2,732	2,536	2,698	2,725
House Sparrow.....	849	954	776	672
Japanese White-eye.....	1,061	658	697	931
Java Sparrow	932	2,724	2,702	3,216
Red-vented Bulbul.....	1,705	1,125	1,309	1,487
Rock Dove.....	314	263	299	327
Spotted Dove.....	1,642	1,228	1,513	1,379
Zebra (Barred) Dove	4,179	3,592	4,112	5,627
Visitor species: <u>4/</u>				
Pacific Golden-Plover.....	1,594	1,037	1,199	1,332
Ruddy Turnstone.....	314	147	245	357

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

2/ Native to Hawaii, but also found elsewhere.

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

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

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

Table 5.40-- HAWAII AUDUBON SOCIETY BIRD COUNT OF THE HONOLULU AREA: 1991 AND 1992

[See headnote and footnotes to the preceding table]

Type of species	Number of species		Number of individuals	
	Dec. 21, 1991	Dec. 20, 1992	Dec. 21, 1991	Dec. 20, 1992
All species	46	48	17,864	18,779
Endemic	7	7	352	233
Indigenous.....	5	6	566	411
Alien	28	30	15,743	16,648
Visitor	6	5	1,203	1,487

Source: Hawaii Audubon Society, records.

Table 5.41-- TREES ALONG STREETS OR IN PARKS UNDER THE JURISDICTION OF THE CITY AND COUNTY OF HONOLULU: 1989 TO 1993

[As of June 30]

Location	1989	1990	1991	1992	1993
Along City and County streets and highways ^{1/}	123,533	124,650	125,236	127,056	130,458
In City and County parks.....	97,672	98,330	98,599	98,685	99,025

^{1/} Excludes Federal, State, and private thoroughfares.

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

**Table 5.42-- THREATENED, ENDANGERED, AND EXTINCT SPECIES OF
NATIVE FAUNA AND FLORA: DECEMBER 1990**

Type of fauna or flora	Native species	Candidate ^{1/}	Proposed endangered ^{1/}	Threatened ^{1/}	Endangered ^{1/}	Extinct ^{2/}
Land mammals	1	-	-	-	1	-
Marine mammals	17	-	-	-	8	-
Reptiles and amphibians	5	-	-	3	2	-
Birds	77	-	-	1	29	23
Freshwater fish	5	-	-	-	-	-
Invertebrates	(<u>3/</u>)	150	-	-	1	<u>4/</u> 88
Plants	956	280	52	-	19	(NA)

^{1/} Categories of the Federal List of Endangered and Threatened Species, as published in the *Federal Register*. Candidate species are those being officially considered for listing as threatened or endangered.

^{2/} Since 1778.

^{3/} Not known, but nearly 10,000 native species of insects and more than 1,000 native species of land snails have been estimated.

^{4/} Incomplete and probably much higher.

Source: U.S. Department of the Interior, Fish and Wildlife Service, *Endangered and Threatened Wildlife and Plants* (January 1989); P. Q. Tomich, *Mammals in Hawaii* (1969); Robert L. Pyle, "Checklist of Birds of Hawaii," *The 'Elepaio*, November 1983; correspondence from W. C. Gagne, Entomology Department, Bishop Museum, July 3, 1985; H. St. John, *List and Summary of the Flowering Plants in the Hawaiian Islands* (1973), p. 519; University of Hawaii Department of Geography, *Atlas of Hawaii* (1983), pp. 80 and 83; Gordon Nishida, Entomology Department, Bishop Museum; Warren L. Wagner, Derral R. Herbst, S. H. Sohmer, *Manual of Flowering Plants of Hawaii* (1990).