Hawaii Stream Assessment

A Preliminary Appraisal of Hawaii's Stream Resources

A Cooperative Project

The State of Hawaii
Commission on Water Resource Management

The National Park Service
Rivers and Trails Conservation Assistance Program

EXHIBIT S-2

Hawaii Stream Assessment

A Preliminary Appraisal of Hawaii's Stream Resources

Report R84

Prepared for

COMMISSION ON WATER RESOURCE MANAGEMENT
State of Hawaii

By

HAWAII COOPERATIVE PARK SERVICE UNIT
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Honolulu, Hawaii

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Preface

The 1988 Hawaii State Legislature provided the conceptual foundation for the Hawaii Stream Assessment by amending the 1987 Hawaii State Water Code. This amendment provided that the Commission on Water Resource Management (CWRM) "identify rivers or streams, or a portion of a river or stream, which appropriately may be placed within a wild and scenic rivers system, to be preserved and protected as part of the public trust ... the term 'wild and scenic rivers' means rivers or streams, or a portion of a river or stream, of high natural quality or that possess significant scenic value..."

The Hawaii Stream Assessment (HSA) was made possible through the support of the National Park Service's River and Trails Conservation Assistance Program. Additional support was provided by the DLNR's Division of Water Resource Management, including funding for the Hawaii Heritage Program's development of the aquatic database.

The report and its findings and the supporting database of information were prepared by the HSA Study Team which represented the Hawaii State Department of Land and Natural Resources and the U.S. National Park Service with the assistance of committees of experts representing federal and state agencies and private organizations. Streams were inventoried and then assessed for their values in four resource areas: aquatic, riparian, cultural and recreation. These areas cover the beneficial instream uses defined in the State Water Code with the exception of navigation and the protection of traditional and customary Hawaiian rights. While the original intent was to also include important offstream uses, sufficient and verified information was not available in time for this study. It is our understanding that the State Commission on Water Resource Management will consider these missing elements along with the information in this report when making management decisions.

In the judgement of the study team, the existing information, while limited, was sufficient to conclude that the state's surface water resources are limited, fragile, and in need of protective management now. The Water Commission suggested alternatives for a wild and scenic river system be developed. It is important to note that, while alternatives and recommendations are provided, this study does not initiate any action, protection, designation or zoning changes.

The draft report was presented for public comment in September 1990. Public participation was lively, extensive and substantive, and the final report was revised to reflect these comments and concerns.

We hope the Hawaii Stream Assessment will help provide an overview of Hawaii's surface water resources, allowing the evaluation of any given proposal to take place within a statewide context. This final report and the database are submitted to the Water Commission for its use in future decisions about the management of Hawaii's perennial streams.

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To all those who in any manner contributed to the Hawaii Stream Assessment, the authors express their sincere thanks. But, as always in projects of this magnitude, certain individuals contributed far beyond the original commitment. Audrey Newman and Patty Kupchak provided the opportunity for extensive discussion and debate, as well as review and comment. Meredith Ching reminded us of the economic importance of streams. Luciana Honigman prepared the aquatic resource inventory data and bibliography. Maps and many of the tables were developed by Jane Lewis. Simon Chan did much of the data entry later assisted by Billy Tabuio. Susana Chang and Datta Bhambare performed various desktop publishing tasks. Patricia Tummons assisted with editing. Sherrie Samuels was invaluable as primary DLNR contact. Martha Crucius and Drew Parkin contributed a national perspective of river assessments.

Cooperation was the key to the Hawaii Stream Assessment. The strengths of this report are due to the participation by many in government and the private sector. Individuals from Hawaii's state government departments of Land and Natural Resources, Business and Economic Development, and Health; from federal agencies including the U.S. National Park Service, Geological Survey, Army Corps of Engineers, Fish and Wildlife Service; County planning and public works departments; the professional and business community, in particular The Nature Conservancy Hawaii; and the University community were all unfailingly generous with their time, expertise and patience.

Finally, none of this would have happened without the support of the water commissioners, Chairman William Paty, Michael Chun, Richard Cox, Guy Fujimura, John Lewin and Robert Nakata. The Commission on Water Resource Management and the Department of Land and Natural Resources, the primary managers of the state's natural resources, recognized the importance of an inventory and assessment of surface water resources for informed decision-making. The commissioning of this independent project, with its conservation point of view, is an indication of their commitment to long-term care of Hawaii's natural resources.

The authors are grateful to all of the project participants listed on the following pages who made the Hawaii Stream Assessment possible...this is your work.

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BWS: Honolulu Board of Water Supply

CDUA: Conservation Use District Application
COE: U.S. Army Corps of Engineers
CPSU: Cooperative National Park Resources Study Unit
CWRM: Commission on Water Resource Management
CZM: Coastal Zone Management

DAR: Division of Aquatic Resources, DLNR
DBED: Department of Business, Economic Development and Tourism
DLNR: Department of Land and Natural Resources
DLU: Department of Land Utilization
DOA: Department of Agriculture
DOFAW: Division of Forestry and Wildlife, DLNR
DOH: Department of Health
DOWALD: Division of Water and Land Development, DLNR
DWRM: Division of Water Resource Management, DLNR (formerly DOWALD)

EIS: Environmental Impact Statement
EKI: East Kauai Irrigation
EMI: East Maui Irrigation

GIS: Geographic Information System

HALE: Haleakala National Park
HAR: Hawaii Administrative Rules
HRS: Hawaii Revised Statutes
HSA: Hawaii Stream Assessment
HSPA: Hawaii Sugar Planters Association

IG1: Introduced Species Group 1
IG2: Introduced Species Group 2

NARS: Natural Area Reserve System
NASQAN: National Stream Quality Accounting Network
NERR: National Estuarine Research Reserves
NG1: Native Species Group 1
NG2: Native Species Group 2
NNL: National Natural Landmarks
NOAA: National Oceanographic and Atmospheric Administration
NPS: National Park Service

NRDC:	Natural Resources Defense Council
ROS:	Recreation Opportunity Spectrum
SCS:	U.S. Soil Conservation Service
SCAP:	Stream Channel Alteration Permit
TNCH:	The Nature Conservancy of Hawaii
UH:	University of Hawaii
UHEC:	University of Hawaii Environmental Center
USDA:	U.S. Department of Agriculture
USDOE:	U.S. Department of Energy
USFWS:	U.S. Fish and Wildlife Service
USGS:	U.S. Geological Survey

Summary

Summary

The State Commission on Water Resource Management (CWRM) recognized the need for a broad-based collection of existing information on Hawaii's rivers and streams to help it make water protection and management decisions. The CWRM initiated the Hawaii Stream Assessment (HSA) through a cooperative agreement with the National Park Service's (NPS) State and Local Rivers and Trails Conservation Assistance Program. This program was established in response to the National Wild and Scenic Rivers Act, which encourages the NPS to assist states to consider needs and opportunities for establishing state and local wild, and scenic, and recreational river areas (Public Law 90-542, Section 11(a)).

The primary task of the HSA was to identify streams appropriate for protection. It makes no attempt to assess existing or potential offstream use. The HSA presents the conservation point of view.

The Hawaii Stream Assessment is to be used as a reference. The products are a physical inventory of Hawaii's 376 perennial streams and working maps; an assessment of resources associated with these streams; and a database.

The HSA will help policy-makers, resource managers, developers, scientists and the interested public to:

- Locate published information for a particular stream;
- Identify and prioritize areas where information is needed;
- Understand stream resources within a statewide context;
- Make management decisions based on data;
- Develop general stream resource protection guidelines;
- Identify specific streams appropriate for protection and enhancement.

This inventory and assessment is of a general nature, is incomplete, and does not take the place of any specific review and study normally required during the review process.

Study Process

The HSA consolidated considerable published information from diverse sources, data in government and private agency files, and, in some cases, information from knowledgeable people on Hawaii's streams and associated resources. The approach was modeled on a process developed by the NPS and used in more than 20 other states, but with certain modifications to meet Hawaii's unique needs. These modifications included 1) Streams were inventoried as complete units, as opposed to segments, and 2) Perennial was defined to include streams perennial in only part of their course.

A study team from NPS and Hawaii Department of Land and Natural Resources (DLNR) coordinated this effort, under the direction of a steering committee. An inventory of perennial streams and their physical characteristics was developed with the assistance of a Physical Resource Committee and a Water Supply Committee and was based on needs defined by potential users of the study. Four resource areas were also identified: Aquatic, Riparian, Cultural and Recreation. Resource committees composed of individuals with expertise in these areas were established. These committees developed the criteria used to assess stream resources and identified reliable sources of information.

Background

The state has a leading role in watershed ownership and management responsibility. Essentially all Hawaii's perennial streams arise in forest reserves or other state-owned areas. These streams provide unique and essential habitat for flora and fauna. Certain environments such as wetlands and estuaries are dependent on them. Their interface with the sea is critically important. Pre-historic cultures settled around water to take advantage of its benefits, which included irrigation, food, recreation and quiet enjoyment. Today's island inhabitants continue to derive these same benefits and more from streams.

Hawaii's streams are small and fragile. They can affect and be affected by action far beyond their boundaries. Instream flows may be affected by distant tunnels and wells; native fishes ten miles upstream by channelization at the stream mouth; runoff and erosion from the mountains and urban areas ends up on the reef and beaches. It is inappropriate to consider management of segments of Hawaii's streams in isolation. Rather, it is necessary to look at the entire stream within the context of its watershed.

Inventory

Perennial Streams

HSA compiled a list of 376 perennial streams using data from various sources. Over one third of these streams do not flow continuously from the mountains to the ocean but do have sections that are perennial. Most of the 376 streams are named but there is not always agreement on the name. Hawaii's streams are evenly distributed on Kauai, but on the other four main islands they are concentrated in certain areas, primarily the windward sides.

Monitoring

Gaging. Historic and current gaging data was collected from the USGS and included in the inventory. One hundred thirty nine streams have been gaged since 1909; 97 are currently gaged.

Water quality. Physical, chemical, biological and/or sediment water quality information has been collected for 65 streams, 14 of those sites are current. The source and type of data is included in the inventory but not the actual water quality results.

Modifications

Water supply. Some beneficial offstream use of streams is addressed, in particular large agricultural companies identified their use of 125 streams and county water suppliers 34 streams for municipal water. A full inventory and assessment must wait for the completion of the water use certification process.

Dams and diversions. The HSA inventory of dams and diversions was of limited scope. While a list of approximately 100 of Hawaii's streams with dams or diversions along their course are presented, the water use certification will be the definitive source of information.

Hydroelectric power. Existing, proposed and potential hydroelectric power projects have been inventoried. There are currently 18 operating hydroelectric plants that supply 1.5% of Hawaii's electrical energy. Eight more projects have been proposed.

Channelization. Approximately 20% of Hawaii's streams, and almost all of Oahu's streams, have been lined or straightened or otherwise channelized according to data collected from several government agencies and reports.

Special Areas

This category includes areas identified as having natural or cultural resources of particular value. These include estuaries, embayments, wetlands, recovery habitats, special management areas, natural area reserves, wildlife refuges and sanctuaries, private preserves, national natural landmarks, historic sites, research and educational sites, parks, and waterfalls.

Resource Inventory and Assessment

Aquatic Resources

Hawaii's streams support a small but unique aquatic fauna most of which have a life cycle involving both the stream and the sea. Of the 176 streams with biological information, seventy were ranked as outstanding based on the presence of certain native species thought to be indicators of high quality habitat. While it is important to note that studies are more often undertaken in larger, high quality streams, HSA found a positive correlation between good aquatic resources and larger streams and a lack of stream modification.

Riparian Resources

While many riparian values may not be directly stream-related, the quality of the riparian environment directly determines the quality of the stream and the nearshore waters. Native species, native forests, waterbird habitat and wetlands were inventoried and assessed due to a lack of watershed information. Thirty streams were ranked outstanding.

Cultural Resources

Archaeological resources, historic sites and current taro cultivation were inventoried. Only archaeological resources were assessed due to a lack of consistent and reliable data, The committee identified 94 streams as sensitive or highly sensitive to development and named these outstanding. Although archaeological and historical sites correlate somewhat with stream size, their continued existence is not dependent on the condition of the stream. On the other hand, taro culture is dependent on the quantity of water.

Recreational Resources

Boating, camping, fishing, hiking, hunting, nature study areas, parks, scenic views, and swimming were all inventoried. Most of these activities take place from the banks and therefore access and riparian values are important. Eighteen streams were considered to have outstanding recreational resources statewide, 84 streams were ranked regionally (by island) outstanding. Good recreational resources were highly correlated with stream size and a lack of stream channel alteration.

Limitations

The HSA is a broad-based inventory and assessment of the majority of the instream uses described in the state water code. The study does not address important offstream uses of water, water rights, Hawaiian rights, economics, landownership, zoning or navigation, nor does it map or provide location information for the various resources or characteristics. It was based almost entirely on a literature search.

The resource assessment process is based on existing conditions, not past values or potential. Further, there is a higher degree of confidence about those streams ranked as Outstanding than with the other rankings. It may well be that some streams otherwise ranked would qualify as Outstanding if their resources were sufficiently understood. The ranking process should not be used to disregard those streams not ranked as Outstanding.

A rank of "unknown" was assigned to many streams when there was little or no published information available upon which to make an assessment. Streams with missing data should not be interpreted as without resources, but merely as without enough data to support a rank other than unknown.

The user of the report and database is advised to read the descriptions of the recorded data carefully to ascertain where, when and how the information was collected and to remember that this report is merely a snapshot of the state of Hawaii's streams in 1990, and is limited by the data available as of that time.

Hawaii's biological stream resources are not static entities. They can and do change. The information can become outdated quickly. Studies by various authors are not necessary consistent with one another.

Future Actions

Through the HSA a number of possible future actions have been identified.

- **Maintain and enhance the HSA,**
- **Develop long-term stream management strategies,**
- **Institute interim actions to preserve management options.**

Maintain and Enhance the Hawaii Stream Assessment

- **Initiate studies, workshops and development of master plans.**
  - Perform a network analysis of gaging and water quality monitoring programs.
  - Develop a research and management plan for watersheds.
  - Prepare a five year master plan for aquatic research.
  - Commission a statewide hydroelectric master plan.

- **Dedicate a CWRM staff position specifically and exclusively to conservation. The responsibilities of the "stream keeper" would include:**
  - Maintain HSA database;
  - Prepare reports with a conservation point of view for CWRM; and
  - Sponsor and encourage public involvement in stream conservation.

- **Request the Office of State Planning to make streams a theme of the state Geographic Information System.**

Develop Long-Term Stream Management Strategies

- **Adopt a Hawaii Stream Policy which provides that the important natural, cultural and recreational values of Hawaii's streams are protected.**

- **Establish a Hawaii Stream Plan with General Guidelines and a Protected Streams Program.**

General Guidelines

- Review development which affects a stream with reference to HSA resource assessments and special areas.
- Balance offstream water development with preservation of natural, cultural and recreational values.
- Incorporate appropriate types of action for watershed management.
- Consider biota in minimum instream flows.
- Control non-point source pollution.
- Assure publicly accessible stream-related recreational opportunities.
- Target streams with substantial recreational use for water quality enhancement.

Protected Streams

In response to the CWRM mandate to "identify rivers or streams or a portion of a river or stream, which appropriately may be placed within a wild and scenic river system, to be preserved and protected as a part of the public trust" a stream protection program should be established. HSA developed several approaches toward the identification of streams and appropriate levels of protection. These are outlined in the Candidate Streams for Protection and Future Actions chapters.

Interim Actions to Preserve Management Options

- **Declare a moratorium on development of significant streams.**

- **Use HSA General Guidelines in the interim.**

Table 1 Candidate Streams for Protection

(Approach 2 Results: Streams that met either the diversity or blue ribbon criteria)

Code HSA Stream Code Island-Hydrographic Unit-Stream
Stream Stream Name

Diversity of resources: To meet diversity criteria a stream must be outstanding in 3 or more resource areas
- Aq Aquatic
- Cu Cultural
- Rc Recreation
- Rp Riparian

Blue Ribbon Resources: The few very best resources
- Aq Aquatic: Met 3 out of 5 criteria for outstanding
- Cu Cultural: Very high sensitivity, high density, predictability and sensitivity, or over 50 acres of taro cultivation.
- Rc Recreation: Statewide outstanding streams
- Rp Riparian: Met score of 7.

CODE	STREAM	DIVERSITY	BLUE RIBBON
Kauai			
2-1-04	Kalalau	AqCuRc	AqCu
2-1-07	Hanakoa	AqCuRc	
2-1-10	Hanakapiai	AqCuRc	AqCuRc
2-1-11	Maunapuloa	AqCu	AqCu
2-1-14	Wainiha	AqCuRc	Aq
2-1-15	Lumahai	AqRpCu	AqRp
2-1-18	Waioli	Rc	Rc
2-1-19	Hanalei	AqRpCuRc	AqRpCuRc
2-2-08s	Wailua S.	RpCuRc	RpCuRc
2-2-15	Huleia	AqRpRc	Rp
2-3-07	Hanapepe	RpCuRc	
2-4-04s	Waimea S.	RpCuRc	RpRc
2-5-16	Nualolo	AqRpCuRc	Rp
Oahu			
3-1-18	Kahana	AqRpCuRc	CuRc
3-2-13	Maunawili	RpCuRc	Cu
3-4-02	Halawa	Cu	Cu
3-5-05	Kaupuni		Cu
3-6-04	Makaleha		Rp
3-6-06s	Kiikii S.		Rc
Molokai			
4-1-01	Waihanau	Cu	Cu
4-1-03	Waikolu	AqRc	Aq
4-1-09	Pelekunu	AqRpCuRc	AqCu
4-1-15	Wailau	AqCuRc	CuRc
4-1-21	Halawa	AqCuRc	AqCuRc
4-2-04	Waialua	CuRc	Rc
Maui			
6-2-07	Waihee	AqCuRc	CuRc
6-2-08	Waiehu		Cu
6-2-09	Iao	Rc	Rc
6-2-10	Waikapu		Rp
6-4-11	Piinaau	AqRpRc	AqCu
6-4-18	Waiohue Gl.	RcAq	Aq
6-4-22	Hanawi	AqRpRc	AqRp
6-5-13	Oheo Gl.	AqRpRc	AqRc
6-5-24	Manawainui	AqCuRc	
Hawaii			
8-1-11	Halawa	Cu	Cu
8-1-15	Pololu	RpCuRc	RpCu
8-1-16	Honokane Nui	CuRc	Rc
8-1-35	Waimanu	RpCuRc	RpCuRc
8-1-44	Wailoa/Waipio	AqRpCuRc	RpCu
8-1-45	Lalakea	AqCu	CuRc
8-2-33	Kolekole	AqRc	Rc
8-2-56	Honolii	AqRpRc	Aq
8-2-60	Wailuku	RpRc	Rc
8-5-03	Waikoloa	Cu	Cu

(data analysis) of streams and their resources has been used in over 20 states. The design of each state's process is slightly different. The criteria for stream inclusion, physical characteristics inventoried, resources assessed and the final form of the information are unique to the HSA.

Hawaii Stream Assessment Organization

The HSA was established in October 1988. The NPS, which provided the methodology for the project, designated Dr. Clifford Smith, Director, Cooperative National Park Resources Studies Unit at the University of Hawaii at Manoa (CPSU/UH), Principal Investigator. A steering committee designed to provide general direction to the project was chaired by Manabu Tagomori, Deputy Director DLNR. Sherrie Samuels, DLNR Division of Water and Land Development planner, served as primary liaison for the state. Project coordinators were Carol Wilcox, Hawaii Department of Land and Natural Resources and Sallie Edmunds (CPSU/UH). The coordinators, principal investigator, NPS's Martha Crusius, and consultant Drew Parkin formed the study team.

Committees were established and expert opinion sought to help guide the inventory of physical characteristics and water supply. Resource committees were also established to design the inventory and assessment of the four resource areas, i.e., aquatic, cultural, recreation, and riparian, chosen by the steering committee. Members were chosen because of their expertise in the subject area. A considerable amount of data was contributed by staff of federal, state and private agencies, university faculty and volunteers.

The two coordinators were pivotal, collecting and organizing information, facilitating the work of the committees, editing committee reports and writing all other parts of the document.

Project Structure

The HSA was a two year project designed in five phases.

Phase 1 involved planning and establishing budgets and timetables. Products were a preliminary identification of the needs of potential users of this inventory and assessment, and a preliminary bibliography. The project design was based on the needs of potential users.

Phase 2 required a general scoping of the project. Products were draft working maps of perennial streams, a final report of user needs, the physical characteristics to be inventoried, the resource categories to be inventoried and assessed, the relational database design, a preliminary list of perennial streams, and a preliminary list of data sources. Other activities during this phase included convening the working committees, developing a ranking system and public involvement.

Phase 3 concluded the scoping of the HSA. Products were a list of perennial streams, the semi-final bibliography, the minimum standards for data inclusion, evaluation criteria and the database design.

Introduction

Introduction

Though the preservation of natural rivers is first an ecological necessity, the benefits apply to an array of human needs, too. Communities are discovering that rivers kept clean and damless are positive economic influences, especially in metropolitan areas, enhancing local property values and giving habitable character to municipal settings. Rivers provide simple recreations, from self-propelled leisures such as fishing, canoeing, rafting, swimming, hunting, and streamside hiking, to motorized pursuits like boating. Increasingly river lands are gaining protection because floodplains left free of manmade structures act as giant sponges in times of flood, giving low-cost, damage-free control of inundation.

Rivers are refuges for the soul, places of spiritual refreshment where the natural flow and play of running water mirror the movement of life itself. They provide for elemental, relatively unadorned experiences in which man and nature can come together. Ecologically and aesthetically, rivers are indivisible from the larger American land. When preserved, rivers serve as visible symbols of the care we take as temporary inhabitants and full time stewards of a living profound beautiful heritage of nature.

Henry David Thoreau said: "Man is rich in proportion to the number of things he can afford to let alone." That succinctly describes the social purpose of preservation.

W. Kent Olson, American Rivers President

In 1987, the Hawaii State Legislature approved a statewide water code to address the supply and conservation of Hawaii's water resources. It called for the organization of a Commission on Water Resource Management (CWRM) to implement and administer the code. The Commission was charged with planning and coordinating "programs for the development, conservation, protection, control and regulation of water resources based upon the best available information" (HRS, Chapter 174C). A 1988 amendment to the water code further required the commission to "identify rivers or streams, or a portion of a river or stream, which appropriately may be placed within a wild and scenic river system, to be preserved and protected as part of the public trust."

The CWRM had the foresight to recognize the need for an inventory of existing information on Hawaii's rivers and streams to help it make water protection and management decisions. The Commission initiated the Hawaii Stream Assessment (HSA) through a cooperative agreement with the National Park Service (NPS).

The NPS State and Local Rivers and Trails Conservation Assistance Program was established in response to the Wild and Scenic Rivers Act, which encourages the National Park Service to assist states to consider the needs and opportunities for establishing state and local wild, scenic, and recreational river areas (Public Law 90-542, Section 11(a)). The NPS methodology for inventory (data collection) and assessment

Phase 4 involved data collection, refining of the database and preparation of an interim report. The product was a database of the basic information on Hawaiian streams.

Phase 5 required preparation of the final products. These include this technical report with an executive summary and maps, and the Hawaii Stream Assessment database with accompanying guide.

Additional related phases may be undertaken at a future time.

Uses and Limitations

The HSA is a broad-based inventory and assessment of the majority of the instream uses described in the state Water Code. The study does not address important offstream uses of water, water rights, Hawaiian rights, economics, landownership, zoning or navigation nor does it map or provide location information for the various resources or characteristics. It was based almost entirely on a literature search. No field work was done. Neither the report nor the database information is intended to substitute for specific research or assessment.

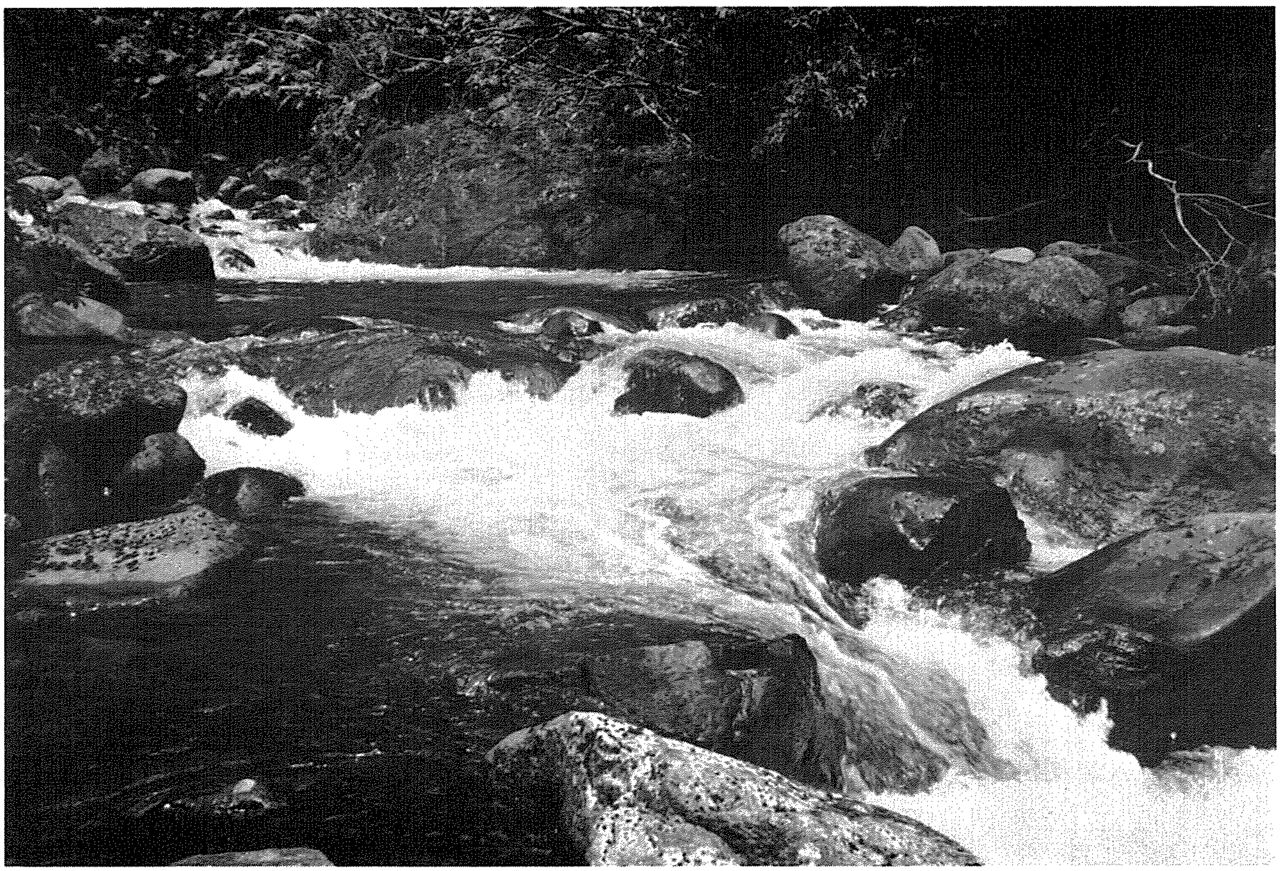
A rank of unknown was assigned to many streams when there was little or no published information available upon which to make an assessment. Streams with missing data should not be interpreted as without resources, but merely as without enough data to support a rank other than unknown.

Hawaii's biological stream resources are not static entities. They can and do change. The information can become outdated quickly since most observations are made on streams during a specific period of time and at specific locations. Furthermore, studies by various authors are not necessarily consistent with one another. The user of the report and database is advised to read the descriptions of the recorded data carefully to ascertain where, when and how the information was collected, and to remember that this report is merely a "snapshot" of the state of Hawaii's streams in 1990 using available information.

The information generated by the Hawaii Stream Assessment may prove useful to public and private sector planners and decision makers in addition to the Commission. Applications for other government agencies could include a comprehensive hydroelectric plan or a recreational development plan, for example. Developers and people in the environmental community may use the information as a guide to flag potential siting problems. Scientists may find the study helps them do broad-based analyses as well as identify areas where further research is needed. Finally, the public may find the Stream Assessment a good source of information about Hawaii's streams. The consolidated source of information will assist all involved in the use and management of Hawaii's streams.

Finally, HSA is a reference document and although several recommendations are provided, this project does not call for action.

Hawaii's Perennial Streams



Hawaii's Perennial Streams

No commonly agreed upon list or map of Hawaii's perennial streams existed when the Hawaii Stream Assessment (HSA) got underway in 1988, but such an inventory was essential. The HSA considered more than 500 streams and major tributaries and finally identified 376 perennial streams. Each stream mouth was assigned a code number to identify it in the report and database and was classified as either continuous or interrupted. Major tributaries were identified and in certain cases assigned code numbers. Stream names and alternative names were confirmed where possible. These factors are described and discussed in the next few sections.

Background

A general description of Hawaii's hydrology is provided to help illustrate the complexity of determining the perennial nature of the streams. The water currently flowing in Hawaii's streams may represent today's rainfall, last week's, last year's or ever water that fell decades ago. The rain may have reached the stream through direct surface run-off, through a shallow layer of soil, bog, or stream bank or by way of deeper dike, perched or basal groundwater.

Tradewinds dominate Hawaii's weather pattern. During these times rainfall is amplified by orographic effects. That is, as air masses are lifted over or around a mountain they cool and create localized rain. The result is a high rainfall frequency and rate on the windward sides of the islands. The continuity of stream flow over time depends on the frequency of rains in the drainage basins and the course that the rainwater must take to the ocean. The sources of stream water, their characteristics, and their location and contribution to stream flow are all important to understanding Hawaii's hydrologic cycle.

The amount of surface flow depends on the intensity and persistence of the rain, the permeability of the soil which includes the degree of saturation. The lag period, the time it takes for rain to enter a stream, is quite short for run-off - minutes to hours to days - and slightly longer for water that flows through the soil. Runoff dominates stream flow in Hawaii and is responsible for the highly variable flow rates. In normal situations, the median flow would approximate the average flow, but this is not true for Hawaiian streams. In Hawaii, streams exceed average flow just 10 percent of the time.

There are four general types of groundwater, dike, perched, confined basal, and unconfined basal, yet only the first three contribute to stream water. Generally groundwater is water that accumulates in an underground aquifer. The distinction among these four groundwater sources is important because of the difference in lag times and the locations of spring which contribute to streams.

Dike waters are usually located at high elevations and therefore may contribute perennial flow to long reaches of streams. The lag time for water to reach dike springs can be from one month to a few years (Table 2). Perched groundwater springs are significant in areas of high to moderately high rainfall and can have a lag period of one week to a few months. Confined basal groundwater springs are generally located below 25 feet in elevation and therefore may contribute to very short perennial streams. Unconfined basal groundwater flows directly into the sea and does not contribute to streams.

Table 2 Sources of Stream Water

Source	Lag time	Nature of Stream Flow
Runoff	short	Flood Flow, Intermittent
Interflow Bog flow	days to weeks	Mostly intermittent flow but respon sible for perennial flow in high rainfall areas.
Perched groundwater	weeks to months	Perennial flows in moderate to high rainfall areas
Dike groundwater	months to years	May contribute substantially to long reaches of perennial streams at upper elevations.
Confined, basal groundwater	years to decades	May contribute substantially to very short, coastal perennial streams.
Unconfined, basal groundwater	years to decades	None. Discharges direct to ocean Does not contribute to stream flow

Streams that are continuously perennial in low rainfall areas often cross rift zones containing high elevation aquifers. In high rainfall areas continuous perennial streams may receive a constant flow of water through soil interflows. Interrupted streams that are perennial at upper elevations may be fed by high elevation springs and then, as they flow over permeable lavas, the flow disappears from the surface.

Sources

Published and Unpublished Documents

DLNR. 1990. Hawaii Water Plan: Water Resources Protection Plan. Prepared by George A. L. Yuen and Associates, Inc. (Draft).

Personal Communications

Cox, Doak. 1990. UH Environmental Center (retired).

Cox, Doak. 1990. Memo to the Hawaii Stream Assessment.

Stream Codes

The study team developed a stream coding system to help users of the Hawaii Stream Assessment identify streams in the report (most tables in this report are organized by stream code) and search the database for particular streams or geographic regions. The codes circumvent the problem of streams with several names and several streams with the same name. The HSA stream code can be composed of up to seven digits and has the format 0-0-00.00.0. The digits refer to:

Island - Hydrographic Unit - Stream Mouth . Primary Tributary . Secondary Tributary . Tertiary Tributary

or

Island - Hydrographic Unit - Stream Mouth . System

Each of these is described below.

ISLAND 0-0-00.00.0

The first digit identifies the island by a unique number assigned by USGS and DOWALD.

2 Kauai;
3 Oahu;
4 Molokai;
6 Maui; and
8 Hawaii.

The islands of Niihau, Kahoolawe and Lanai do not appear in the database because they do not have any perennial streams.

HYDROGRAPHIC UNIT 0-0-00.00.0

The second number identifies hydrographic units within each island. These units are regional drainage areas. The boundaries were established in the 1970s by USGS and DOWALD to facilitate reference. These units are generally coded in numerical order clockwise around each island beginning on the northwest side.

STREAM MOUTH 0-0-00.00.0

Each stream initially included in the HSA list of perennial streams was assigned a stream number. These numbers were assigned clockwise within each hydrographic unit in the order that the streams enter the ocean. Streams added to the HSA later in the study are numbered out of sequence. Gaps in the stream coding system reflect streams that were later excluded from HSA. The stream number is the last number in the stream code unless there is data on a specific tributary.

TRIBUTARY 0-0-00.00.0

The digits separated by decimals identify tributaries. Generally these tributaries are numbered consecutively from the mouth as they appear on the USGS 1:100,000 map. HSA has not assigned tributary numbers to all tributaries, only those that have data of some type. Further assignments can be made as the database is broadened.

SYSTEM 0-0-00s

Several streams have tributaries that drain separate valleys and merge close to the mouth. HSA stream systems are Waimea and Wailua on Kauai, and Kahaluu, Ala Wai, Kiikii, Paukauila and Anahulu on Oahu. The final "s" in the stream code denotes a system (Table 3).

Perennial Classification

The Hawaii Stream Assessment considered more than 500 streams and major tributaries for inclusion as perennial streams. In this study, perennial streams are those which normally have surface flow year-round, in all or part of their course, as opposed to intermittent streams, which are normally dry during part of the year. Streams are considered separate entities when they have a separate mouth to the sea. Canals are included when they serve as the mouth for a perennial stream. Streams with major tributaries that extend into distinctly different valleys yet merge near the sea are called systems. Using these guidelines, the HSA has identified Hawaii's 376 perennial streams.

Methods

HSA classified perennial streams using two definitions:

Continuous streams flow to the sea year-round under normal conditions. This includes some streams with diversions.

Interrupted streams flow year-round in the upper portions and intermittently at lower elevations under normal conditions. The interruption may be natural or man-made.

While the inclusion of interrupted streams may be questionable to some, they are included because there are often significant resources associated with their perennial segments. Interruptions typically occur in two ways: naturally, when the stream disappears into the porous ground at the lower elevations; or, by modification, when water is removed from the stream by diversion or by depletion of groundwater. A diversion does not necessarily mean a stream is categorized as interrupted; if water occurs below the diversion, a stream is categorized as continuous. Diversions are discussed in a later section of this report.

The two primary sources for perennial information were Timbol and Maciolek (1978) and USGS topographic quadrangle maps. These comprehensive works were reviewed and augmented by HSA project participants to develop the final HSA perennial stream classification list.

Results

There are 376 streams on HSA's perennial stream lists (Tables 4, 5). Sixty-one are on Kauai, 57 on Oahu, 36 on Molokai, 90 on Maui, and 132 on Hawaii. Niihau, Lanai and Kahoolawe have no perennial streams. Seven of these are stream systems (Table 3). Approximately two-thirds of Hawaii's streams are continuous, one third interrupted.

Table 3 Seven Stream Systems*

Kauai

Wailua River System (2-2-08s)
- Opaekaa
- Wailua segment
- North Fork Wailua
- South Fork Wailua

Waimea River System (2-4-04s)
- Makaweli (2nd trib) Olokele
- Waimea Segment (2nd trib) Mokihana, Waialae, Waiahulu(3nd trib-Kokee, Halemano), Koaie, Poomau (3nd trib- Mohihi, Kawaikoi)

Oahu

Kahaluu System (3-2-07s)
- Waihee
- Kahaluu
- Ahuimanu

Ala Wai Canal System (3-3-07s)
- Manoa (2nd trib) Palolo
- Makiki

Kiikii System (3-6-06s)
- Poamoho
- Kaukonahua (2nd trib) North Kaukonahua, South Kaukonahua

Paukauila System (3-6-07s)
- Opaeula
- Helemano

Anahulu System (3-6-08s)
- Kawaiiki
- Kawailoa
- Kawainui

* Streams with two or more major tributaries that extend into distinctly different valleys and converge on the coastal plains.

Canals and the streams that feed them are: on Kauai Waikaea Canal(2-2-06) – Konohiki; and on Oahu Kawainui Canal(3-2-13) – Maunawili stream; Ala Wai Canal (3-3-07s) – Manoa, Makiki, and Palolo stream.

Discussion

Intermittent streams have been excluded from this study but should not be considered unimportant. They serve as drainageways and recharge areas, and may have essential ecological functions as well.

The most obvious conclusion from the inventory and mapping of perennial streams is their uneven geographic distribution. Most perennial streams are concentrated on the windward sides of the islands. Also, larger stream systems have developed only on the geologically older islands of Kauai and Oahu. Whether these networks provide additional or unique resources has not been determined.

Limitations

For many reasons, the classification of streams is not precise or static. There may be disagreement and error with respect to the perennial nature of individual streams.

The 100-plus streams on Hawaii's Kohala-Hamakua coast are particularly difficult to see and access and there is very little information on them. For these reasons, the level of confidence regarding perennial status and other attributes for most of these streams is low.

Sources

Published and Unpublished Documents

Garratt Callahan Company. 1986. East & West Wailuaiki Hydroelectric Project FEIS.

Hirota, Sam O. Inc. 1978. Determination of Headwaters for Oahu and Kauai with maps. U.S. Army Corps of Engineers, Honolulu.

Kilauea Agricultural Water Management Study Report. 1984. U.S. Dept of Agriculture/DLNR.

DLNR. 1990. Hawaii Water Plan: Water Resources Protection plan. Prepared by George A. L. Yuen and Associates, Inc. (Draft).

Timbol, A.S. and John Maciolek. 1978. Stream Channel Modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. FWS/OBS-78/16. Prepared for USFWS National Stream Alteration Team. Columbia, Missouri.

Maps

USGS maps 1:24,000 (quads), 1:100,000, 1:125,000

U.S. Army Corps of Engineers, Headwater Survey maps, 1978.

Personal Communications

Cox, Doak. UH Environmental Center (retired). 1990.

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Telfer, Tom, Alvin Kyono, Galen Kawakami, Ralph Saito, Bob Hobdy, Wes Wong, Jon Giffin. DLNR, Division of Forestry. 1990.

Gill, Lorin. Moanalua Gardens Foundation. 1990.

Gon, Sam. The Nature Conservancy Hawaii. 1990.

HSA State and Regional Recreation Committees. 1990.

Timbol, Amadeo. Kauai Community College. 1990.

Stream Names

There is not always agreement on stream names or spellings. Changes occur as information is passed by word of mouth, when mistakes are published and later accepted as correct, and as streams are realigned, channelized, or otherwise developed.

The task of identifying names for all of the perennial streams included in this study was far more difficult than anticipated. Even the most commonly used source of geographic information, the United States Geological Survey topographic quad map, does not list names for all of the streams drawn on its maps. Timbol and Maciolek (1978) found nearly one fourth of the streams they identified to be unnamed and therefore chose names from the surrounding environment. As a result, the sources of the "Names" and "Alternate Names" used in this study are referenced in the database. The stream was assigned a stream code and identified as "Unnamed"when the stream name was not identified by any of our sources.

This list of names and alternate names may well contain errors and omissions. However, it reflects considerable information collected from a review of documents and personal communications with people from federal and state government agencies, private organizations and various regions.

HSA has chosen not to use Hawaiian diacritical marks in place names to be consistent with our primary source of place names, the U.S. Geological Survey and due to the constraints of time and expertise. It is recognized that diacritical marks are extremely important in Hawaiian place names and a supplement to this report would be quite valuable.

Methods

The HSA used names printed on USGS maps and those used by Timbol and Maciolek (1978) as primary sources. These names were checked against Pukui et al. (1974) and the Bishop Museum's place names maps. They were then drafted on the HSA working map.

This list and updated versions of it were circulated for review throughout the project. As stream name information was collected, the study team determined which would be the "Name" and the "Alternate name." Priority was generally given to USGS names due to the wide use of USGS reference maps. All "Names," "Alternate names" and "Tributary names and sources" are noted in the database. The sources of this information appear below.

Results

Only five of the 36 initially unnamed streams included in this study remain unnamed. The primary source is USGS (Table 5, 6). Twenty-seven streams have alternate names or spellings which are noted in the database.

Sources

Published and Unpublished Documents

Pukui, Mary Kawena. 1974. *Place Names of Hawaii.* University of Hawaii Press, Honolulu.

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Maps

Bishop Museum. 1974. Maps with place names. Prepared by Lee Motler, Librarian.

Hirota, Sam O. Inc. 1978. Determination of Headwaters for Oahu and Kauai with maps. U.S. Army Corps of Engineers, Honolulu.

U.S. Geological Survey. 1970's. Topographic Quadrangle Maps, 1:24,000.

Personal Communications

Samuels, Sherrie. Department of Land and Natural Resources, DOWALD.

Table 4 Perennial Streams

(Alphabetically)

NAME	Stream name at mouth	ISLAND	Island location
CODE	HSA Stream Code island - hydrographic unit - stream/system	QUAD	USGS Quadrangle map at mouth

NAME	CODE	ISLAND	QUAD
Aakukui	2-4-02	Kauai	Hanapepe
Aamakao	8-1-12	Hawaii	Hawi
Aamanu	8-1-79	Hawaii	Kukaiau
Ahole	8-2-18	Hawaii	Papaaloa
Aiea	3-4-03	Oahu	Waipahu
Ala Wai S.	3-3-07s	Oahu	Honolulu
Alaalaula	6-5-06	Maui	Kipahulu
Alakahi	8-2-45	Hawaii	Papaikou
Aleamai	8-2-48	Hawaii	Papaikou
Alelele	6-5-20	Maui	Kaupo
Alia	8-2-39	Hawaii	Papaikou
Alilipali	8-1-71	Hawaii	Honokaa
Aliomanu	2-1-36	Kauai	Anahola
Anahola	2-2-01	Kauai	Anahola
Anahulu S.	3-6-08s	Oahu	Haleiwa
Anapuhi	4-1-05	Molokai	Kamalo
Anini	2-1-21	Kauai	Hanalei
Awaawapuhi	2-1-01	Kauai	Makaha
E. Waiakalua	2-1-30	Kauai	Anahola
E. Wailuaiki	6-4-16	Maui	Keanae
E. Waipake	2-1-33	Kauai	Anahola
Haakoa	8-2-10	Hawaii	Papaaloa
Haeleele	2-5-10	Kauai	Makaha
Hahalawe	6-5-11	Maui	Kipahulu
Haipuaena	6-4-07	Maui	Keanae
Hakaaano	4-1-22	Molokai	Halawa
Hakalau	8-2-32	Hawaii	Papaaloa
Hakipuu	3-2-01	Oahu	Kahana
Halawa	8-1-11	Hawaii	Hawi
Halawa	4-1-21	Molokai	Halawa
Halawa	3-4-02	Oahu	Puuloa
Haloa	8-5-01	Hawaii	Kamuela
Haloku	4-1-11	Molokai	Kamalo
Hanakapiai	2-1-10	Kauai	Haena
Hanakoa	2-1-07	Kauai	Haena
Hanalei R.	2-1-19	Kauai	Hanalei
Hanamaulu	2-2-12	Kauai	Kapaa
Hanapepe	2-3-07	Kauai	Hanapepe
Hanaula	8-1-06	Hawaii	Hawi
Hanawana	6-3-13	Maui	Haiku
Hanawi	6-4-22	Maui	Nahiku
Hanawi	8-2-46	Hawaii	Papaikou
Hanehoi	6-3-11	Maui	Haiku
Haneoo	6-5-02	Maui	Hana
Hapahapai	8-1-07	Hawaii	Hawi
Heeia	3-2-08	Oahu	Kaneohe
Heleleikeoha	6-4-31	Maui	Hana
Hoalua	6-3-12	Maui	Haiku
Honanana	6-2-02	Maui	Kahakuloa
Honokahua	6-1-09	Maui	Honolua
Honokane Iki	8-1-17	Hawaii	Honokane
Honokane Nui	8-1-16	Hawaii	Honokane

NAME	CODE	ISLAND	QUAD
Honokea	8-1-20	Hawaii	Honokane
Honokohau	6-1-11	Maui	Honolua
Honokowai	6-1-07	Maui	Lahaina
Honolewa	6-5-08	Maui	Kipahulu
Honolii	8-2-56	Hawaii	Papaikou
Honolua	6-1-10	Maui	Honolua
Honomanu	6-4-09	Maui	Keanae
Honomu	8-2-35	Hawaii	Papaikou
Honomuni	4-2-06	Molokai	Halawa
Honopou	6-3-08	Maui	Haiku
Honopu	2-1-02	Kauai	Makaha
Honopue	8-1-22	Hawaii	Honokane
Honoulimaloo	4-2-02	Molokai	Halawa
Honouliuli	3-4-11	Oahu	Ewa
Honouliwai	4-2-03	Molokai	Halawa
Hoolawa	6-3-09	Maui	Haiku
Hoolulu	2-1-09	Kauai	Haena
Huleia	2-2-15	Kauai	Lihue
Iao	6-2-09	Maui	Wailuku
Kaaawa	3-1-19	Oahu	Kahana
Kaahakini	8-2-62	Hawaii	Hilo
Kaaheiki	8-2-22	Hawaii	Papaaloa
Kaaiea	6-4-02	Maui	Keanae
Kaala	8-1-85	Hawaii	Kukaiau
Kaalaea	3-2-05	Oahu	Kaneohe
Kaapahu	6-5-18	Maui	Kipahulu
Kaapoko	8-2-51	Hawaii	Papaikou
Kaawalii	8-2-02	Hawaii	Kukaiau
Kaawaloa	2-5-07	Kauai	Kekaha
Kaelepulu Canal	3-2-14	Oahu	Mokapu
Kahakuloa	6-2-03	Maui	Kahakuloa
Kahaluu S.	3-2-07s	Oahu	Kaneohe
Kahana	6-1-08	Maui	Honolua
Kahana	3-1-18	Oahu	Kahana

NAME	CODE	ISLAND	QUAD
Kahananui	4-2-10	Molokai	Kamalo
Kahaupu	8-1-65	Hawaii	Honokaa
Kahawaihapapa	6-4-27	Maui	Hana
Kahawailiili	8-1-66	Hawaii	Honokaa
Kahawainui	3-1-07	Oahu	Kahuku
Kahiwa	4-1-18	Molokai	Halawa
Kahoma	6-1-05	Maui	Lahaina
Kahoopuu	8-1-39	Hawaii	Kukuihaele
Kahuku	8-2-25	Hawaii	Papaaloa
Kaieie	8-2-49	Hawaii	Papaikou
Kailiili	4-1-08	Molokai	Kamalo
Kailikaula	8-1-21	Hawaii	Honokane
Kailua	6-3-14	Maui	Keanae
Kaimu	8-1-33	Hawaii	Honokane
Kainalu	4-2-05	Molokai	Halawa
Kaipapau	3-1-10	Oahu	Hauula
Kaiwiki	8-1-89	Hawaii	Kukaiau
Kaiwilahilahi	8-2-09	Hawaii	Papaaloa
Kakipi	6-3-07	Maui	Haiku
Kakiweka	6-5-10	Maui	Kipahulu
Kalalau	2-1-04	Kauai	Haena
Kalaoa	8-2-47	Hawaii	Papaikou
Kalapahapu Gl	8-1-81	Hawaii	Kukaiau
Kalauao	3-4-04	Oahu	Waipahu
Kalele Gl.	8-1-18	Hawaii	Honokane
Kalepa	6-5-21	Maui	Kaupo
Kalihi	3-3-11	Oahu	Honolulu
Kalihiwai R.	2-1-25	Kauai	Hanalei
Kalopa	8-1-68	Hawaii	Honokaa
Kaluaaha	4-2-09	Molokai	Kamalo
Kaluahine Falls	8-1-46	Hawaii	Kukuihaele
Kaluanui	3-1-13	Oahu	Hauula
Kamaee	8-2-31	Hawaii	Papaaloa
Kamalo	4-2-14	Molokai	Kamalo

NAME	CODE	ISLAND	QUAD
Kaneohe	3-2-10	Oahu	Kaneohe
Kaohaoha	8-2-01	Hawaii	Kukaiau
Kapaa	2-2-04	Kauai	Kapaa
Kapalama	3-3-10	Oahu	Honolulu
Kapaula	6-4-21	Maui	Nahiku
Kapehu	8-2-37	Hawaii	Papaikou
Kapehu	8-2-12	Hawaii	Papaaloa
Kapia	6-5-03	Maui	Hana
Kapue	8-2-53	Hawaii	Papaikou
Kapulena	8-1-52	Hawaii	Kukuihaele
Kauaula	6-1-04	Maui	Lahaina
Kauhao	2-5-13	Kauai	Makaha
Kaula	8-1-90	Hawaii	Kukaiau
Kaulaula	2-5-09	Kauai	Makaha
Kaumoali Gl	8-1-73	Hawaii	Honokaa
Kaupakulua	6-3-03	Maui	Haiku
Kaupuni	3-5-05	Oahu	Waianae
Kawa	3-2-11	Oahu	Kaneohe
Kawaikalia	8-1-53	Hawaii	Kukuihaele
Kawailoa	2-2-10	Kauai	Kapaa
Kawainui	4-1-19	Molokai	Halawa
Kawainui	8-2-43	Hawaii	Papaikou
Kawainui/ Maunawili	3-2-13	Oahu	Mokapu
Kawaipapa	6-4-34	Maui	Hana
Kawakoe	6-4-32	Maui	Hana
Kawela	3-1-04	Oahu	Kahuku
Kawela	4-2-15	Molokai	Kaunakakai
Keaahala	3-2-09	Oahu	Kaneohe
Keaaiki	6-4-28	Maui	Hana
Keahua	8-1-67	Hawaii	Honokaa
Kealakaha	8-1-86	Hawaii	Kukaiau
Keawanui	4-1-07	Molokai	Kamalo
Kihalani	8-2-08	Hawaii	Papaaloa
Kiikii S.	3-6-06s	Oahu	Haleiwa
Kilau	8-2-05	Hawaii	Papaaloa
Kilauea	2-1-28	Kauai	Anahola
Kinekine Ditch	2-5-06	Kauai	Kekaha
Kipu Kai	2-3-01	Kauai	Lihue
Koholalele Gl	8-1-80	Hawaii	Kukaiau
Kolea	6-4-03	Maui	Keanae
Kolealiilii	8-1-23	Hawaii	Honokane
Kolekole	8-2-33	Hawaii	Papaikou
Koloa Gl.	3-1-09	Oahu	Kahuku
Kopiliula	6-4-17	Maui	Keanae
Koukouai	6-5-15	Maui	Kipahulu
Kuhiwa	6-4-24	Maui	Nahiku
Kuiaha	6-3-02	Maui	Haiku
Kukaiau	8-1-82	Hawaii	Kukaiau
Kukui	8-1-29	Hawaii	Honokane
Kukuilamalamahii	8-1-70	Hawaii	Honokaa
Kukuiula	6-5-17	Maui	Kipahulu
Kulanakii	8-2-17	Hawaii	Papaaloa
Kulihaili	2-1-29	Kauai	Anahola
Kuliouou	3-3-03	Oahu	Koko
Kumakua	8-1-03	Hawaii	Hawi
Kumukumu	2-2-02	Kauai	Kapaa
Kupapaulua	8-1-88	Hawaii	Kukaiau
Kuwaikahi	8-2-07	Hawaii	Papaaloa
Laimi	8-2-36	Hawaii	Papaikou
Lalakea	8-1-45	Hawaii	Kukuihaele
Lamimaumau	8-5-02	Hawaii	Kamuela
Lanikele	6-4-30	Maui	Hana
Launiupoku	6-1-03	Maui	Lahaina
Laupahoehoe	8-2-04	Hawaii	Papaaloa
Lawai	2-3-04	Kauai	Koloa
Lelekea	6-5-19	Maui	Kaupo
Limahuli	2-1-12	Kauai	Haena
Loko Ea	3-6-09	Oahu	Haleiwa

NAME	CODE	ISLAND	QUAD
Lumahai R.	2-1-15	Kauai	Hanalei
Maakua	3-1-11	Oahu	Hauula
Mahinauli	2-4-01	Kauai	Hanapepe
Maili	8-2-57	Hawaii	Papaikou
Mailiili	3-5-04	Oahu	Waianae
Makaha	3-5-07	Oahu	Waianae
Makahanaloa	8-2-40	Hawaii	Papaikou
Makaleha	3-6-04	Oahu	Kaena
Makamakaole	6-2-06	Maui	Kahakuloa
Makapipi	6-4-23	Maui	Nahiku
Makaua	3-1-20	Oahu	Kahana
Makea	8-2-38	Hawaii	Papaikou
Makua	3-5-08	Oahu	Kaena
Malaekahana	3-1-06	Oahu	Kahuku
Malanahae	8-1-54	Hawaii	Kukuihaele
Maliko	6-3-01	Maui	Paia
Manawai	4-2-11	Molokai	Kamalo
Manawaiiao	6-3-04	Maui	Haiku
Manawaikeae	6-4-26	Maui	Hana
Manawainui	6-5-24	Maui	Kaupo
Manoa	2-1-13	Kauai	Haena
Manoloa	8-2-20	Hawaii	Papaaloa
Manowaiopae	8-2-06	Hawaii	Papaaloa
Manuwaikaalio	8-1-37	Hawaii	Kukuihaele
Mapulehu	4-2-08	Molokai	Halawa
Maulua	8-2-14	Hawaii	Papaaloa
Maunapuluo	2-1-11	Kauai	Haena
Milolii	2-5-15	Kauai	Makaha
Moanalua	3-3-12	Oahu	Honolulu
Moikeha Canal	2-2-05	Kauai	Kapaa
Moloaa	2-1-34	Kauai	Anahola
Moomoonui	6-5-01	Maui	Hana
Nahomalu	2-5-08	Kauai	Kekaha
Nailiilihaele	6-3-15	Maui	Keanae

NAME	CODE	ISLAND	QUAD
Nakeikionaiwi	2-1-03	Kauai	Haena
Nakooko	8-1-25	Hawaii	Honokane
Naluea	8-1-38	Hawaii	Kukuihaele
Nanakuli	3-5-01	Oahu	Schofield
Nanue	8-2-27	Hawaii	Papaaloa
Nawiliwili	2-2-13	Kauai	Lihue
Nienie	8-1-61	Hawaii	Honokaa
Ninole	8-2-21	Hawaii	Papaaloa
Niu	3-3-04	Oahu	Koko
Niulii	8-1-13	Hawaii	Honokane
Nuaailua	6-4-10	Maui	Keanae
Nualolo	2-5-16	Kauai	Makaha
Nuanuaaloa	6-5-22	Maui	Kaupo
Nuuanu	3-3-09	Oahu	Honolulu
Oheo Gl	6-5-13	Maui	Kipahulu
Ohia	6-4-12	Maui	Keanae
Ohia	4-2-12	Molokai	Kamalo
Ohiahuea	8-1-24	Hawaii	Honokane
Oio	3-1-05	Oahu	Kahuku
Oloupena	4-1-12	Molokai	Kamalo
Olowalu	6-1-02	Maui	Olowalu
Onomea	8-2-44	Hawaii	Papaikou
Oopuola	6-4-01	Maui	Keanae
Opea	8-2-28	Hawaii	Papaaloa
Opelu	6-5-16	Maui	Kipahulu
Paakea	6-4-19	Maui	Nahiku
Paauilo	8-1-78	Hawaii	Kukaiau
Pae	8-1-34	Hawaii	Honokane
Paeohe	8-2-13	Hawaii	Papaaloa
Pahale	8-2-11	Hawaii	Papaaloa
Paheehee	8-2-34	Hawaii	Papaikou
Pahoehoe	8-2-54	Hawaii	Papaikou
Pali Akamoa	8-1-08	Hawaii	Hawi
Paopao	8-1-30	Hawaii	Honokane

NAME	CODE	ISLAND	QUAD
Papaa	2-1-35	Kauai	Anahola
Papaahawahawa	6-5-05	Maui	Kipahulu
Papaikou	8-2-52	Hawaii	Papaikou
Papio	4-2-16	Molokai	Halawa
Papuaa	8-1-62	Hawaii	Honokaa
Paukaa	8-2-55	Hawaii	Papaikou
Paukauila S.	3-6-07s	Oahu	Haleiwa
Paumalu	3-1-03	Oahu	Waimea
Peleau	8-2-29	Hawaii	Papaaloa
Pelekunu	4-1-09	Molokai	Kamalo
Piinaau	6-4-11	Maui	Keanae
Pilaa	2-1-31	Kauai	Anahola
Pipiwai	4-1-20	Molokai	Halawa
Poelua	6-2-01	Maui	Kahakuloa
Pohakuao	2-1-05	Kauai	Haena
Pohakupili	4-2-01	Molokai	Halawa
Pohakupuka	8-2-16	Hawaii	Papaaloa
Pololu	8-1-15	Hawaii	Honokane
Poupou	8-2-19	Hawaii	Papaaloa
Puaaluu	6-5-12	Maui	Kipahulu
Puali	2-2-14	Kauai	Lihue
Pukihae	8-2-59	Hawaii	Hilo
Pukoa	8-1-36	Hawaii	Honokane
Punalau	6-4-08	Maui	Keanae
Punalulu	8-1-32	Hawaii	Honokane
Punaluu	3-1-16	Oahu	Kahana
Puohokamoa	6-4-06	Maui	Keanae
Puukaoku	4-1-13	Molokai	Kamalo
Puukumu	2-1-26	Kauai	Hanalei
Puuokalepa	8-2-50	Hawaii	Papaikou
Uaoa	6-3-05	Maui	Haiku
Ukumehame	6-1-01	Maui	Olowalu
Ulaino	6-4-33	Maui	Hana
Ulehawa	3-5-02	Oahu	Waianae

NAME	CODE	ISLAND	QUAD
Umauma	8-2-30	Hawaii	Papaaloa
Unnamed	3-6-03	Oahu	Kaena
Unnamed	2-1-27	Kauai	Anahola
Unnamed	3-1-21	Oahu	Kahana
Unnamed	6-4-36	Maui	Hana
Unnamed	8-1-10	Hawaii	Hawi
W. Wailuaiki	6-4-15	Maui	Keanae
W. Waipake	2-1-32	Kauai	Anahola
Wahiawa	2-3-06	Kauai	Hanapepe
Wahikuli	6-1-06	Maui	Lahaina
Waiaaka	6-4-20	Maui	Nahiku
Waiaalala	8-1-31	Hawaii	Honokane
Waiaama	8-2-42	Hawaii	Papaikou
Waiaha	8-4-02	Hawaii	Kailua
Waiahole	3-2-04	Oahu	Kaneohe
Waiahookalo	4-1-17	Molokai	Halawa
Waiahuakua	2-1-08	Kauai	Haena
Waialaenui	3-3-06	Oahu	Honolulu
Waialeale	8-1-50	Hawaii	Kukuihaele
Waialeia	4-1-02	Molokai	Kamalo
Waialua	4-2-04	Molokai	Halawa
Unnamed	3-2-03	Oahu	Kaneohe
Waiapuka	8-1-26	Hawaii	Honokane
Waiawa	3-4-06	Oahu	Waipahu
Waiehu	6-2-08	Maui	Wailuku
Waiehu	8-2-26	Hawaii	Papaaloa
Waieli	6-5-09	Maui	Kipahulu
Waihanau	4-1-01	Molokai	Kaunakakai
Waihee R.	6-2-07	Maui	Wailuku
Waihole	6-4-25	Maui	Nahiku
Waikaalulu	8-1-69	Hawaii	Honokaa
Waikaea Canal	2-2-06	Kauai	Kapaa
Waikaloa	8-1-27	Hawaii	Honokane
Waikama	8-1-14	Hawaii	Honokane

NAME	CODE	ISLAND	QUAD
Waikamoi	6-4-04	Maui	Keanae
Waikane	3-2-02	Oahu	Kaneohe
Waikapu	6-2-10	Maui	Maalaea
Waikaumalo	8-2-24	Hawaii	Papaaloa
Waikele	3-4-10	Oahu	Waipahu
Waikoko	2-1-16	Kauai	Hanalei
Waikoloa	8-1-51	Hawaii	Kukuihaele
Waikoloa	8-5-03	Hawaii	Kawaihae
Waikolu	8-2-23	Hawaii	Papaaloa
Waikolu	4-1-03	Molokai	Kamalo
Waikomo	2-3-02	Kauai	Koloa
Wailau	4-1-15	Molokai	Kamalo
Waileia	2-1-20	Kauai	Hanalei
Wailele	4-1-14	Molokai	Kamalo
Wailele Gl.	3-1-08	Oahu	Kahuku
Wailoa R.	8-2-61	Hawaii	Hilo
Wailoa/Waipio	8-1-44	Hawaii	Kukuihaele
Wailua	6-5-07	Maui	Kipahulu
Wailua S.	2-2-08s	Kauai	Kapaa
Wailuanui	6-4-14	Maui	Keanae
Wailuku R.	8-2-60	Hawaii	Hilo
Wailupe	3-3-05	Oahu	Koko
Waimaauou	8-2-41	Hawaii	Papaikou
Waimaile	8-1-28	Hawaii	Honokane
Waimalu	3-4-05	Oahu	Waipahu
Waimanalo	3-2-15	Oahu	Koko

NAME	CODE	ISLAND	QUAD
Waimanu	8-1-35	Hawaii	Honokane
Waimea R.	3-6-10	Oahu	Waimea
Waimea S.	2-4-04s	Kauai	Kekaha
Wainaia	8-1-09	Hawaii	Hawi
Wainene	4-1-04	Molokai	Kamalo
Wainiha R.	2-1-14	Kauai	Haena
Waiohonu	6-5-04	Maui	Kipahulu
Waiohookalo	4-1-06	Molokai	Kamalo
Waiohue Gl.	6-4-18	Maui	Nahiku
Waiokamilo	6-4-13	Maui	Keanae
Waiolaa	2-1-06	Kauai	Haena
Waiolai	6-2-05	Maui	Kahakuloa
Waioli	2-1-18	Kauai	Hanalei
Waioni	6-4-29	Maui	Hana
Waipa	2-1-17	Kauai	Hanalei
Waipahi	8-1-19	Hawaii	Honokane
Waipahoehoe	8-1-42	Hawaii	Kukuihaele
Waipao	2-4-03	Kauai	Hanapepe
Waipio	6-3-10	Maui	Haiku
Waipu	4-1-10	Molokai	Kamalo
Waipunahina	8-1-76	Hawaii	Honokaa
Waipunahoe	8-1-49	Hawaii	Kukuihaele
Waipunalau Gl	8-1-77	Hawaii	Kukaiau
Waipunalei	8-2-03	Hawaii	Keanakolu
Waiulili	8-1-47	Hawaii	Kukuihaele
Wawaia	4-2-13	Molokai	Kamalo

Table 5 Perennial Streams

(By Island, by Code)

CODE	HSA code; island-hydrographic unit-stream (system)	TRIB	Tributary
		Y	stream has listed tributaries in HSA database
STREAM	Stream name at mouth	N	stream has no listed tributaries in HSA database
QUAD	USGS Quadrangle map of stream mouth	CONT/INT	Continuous/Interrupted
		C	Stream flows to the sea year-round
		I	Stream flows year-round in the upper portions, and intermittently at lower elevations

CODE	STREAM	QUAD	TRIB	CONT/INT
Kauai				
2-1-01	Awaawapuhi	Makaha	N	C
2-1-02	Honopu	Makaha	N	C
2-1-03	Nakeikionaiwi	Haena	N	C
2-1-04	Kalalau	Haena	N	C
2-1-05	Pohakuao	Haena	N	C
2-1-06	Waiolaa	Haena	N	C
2-1-07	Hanakoa	Haena	N	C
2-1-08	Waiahuakua	Haena	N	C
2-1-09	Hoolulu	Haena	N	C
2-1-10	Hanakapiai	Haena	N	C
2-1-11	Maunapuluo	Haena	N	C
2-1-12	Limahuli	Haena	N	C
2-1-13	Manoa	Haena	N	C
2-1-14	Wainiha R.	Haena	Y	C
2-1-15	Lumahai R.	Hanalei	N	C
2-1-16	Waikoko	Hanalei	N	C
2-1-17	Waipa	Hanalei	N	C
2-1-18	Waioli	Hanalei	Y	C
2-1-19	Hanalei R.	Hanalei	Y	C
2-1-20	Waileia	Hanalei	N	C
2-1-21	Anini	Hanalei	N	C
2-1-25	Kalihiwai R.	Hanalei	Y	C
2-1-26	Puukumu	Hanalei	N	C
2-1-27	Unnamed	Anahola	N	C
2-1-28	Kilauea	Anahola	Y	C
2-1-29	Kulihaili	Anahola	N	C
2-1-30	E. Waiakalua	Anahola	N	I
2-1-31	Pilaa	Anahola	N	C
2-1-32	W. Waipake	Anahola	N	I
2-1-33	E. Waipake	Anahola	N	I
2-1-34	Moloaa	Anahola	N	C
2-1-35	Papaa	Anahola	N	C
2-1-36	Aliomanu	Anahola	N	I
2-2-01	Anahola	Anahola	Y	C
2-2-02	Kumukumu	Kapaa	N	I
2-2-04	Kapaa	Kapaa	Y	C
2-2-05	Moikeha Canal	Kapaa	N	C
2-2-06	Waikaea Canal	Kapaa	N	C
2-2-08s	Wailua S.	Kapaa	Y	C
2-2-10	Kawailoa	Kapaa	N	I
2-2-12	Hanamaulu	Kapaa	N	C
2-2-13	Nawiliwili	Lihue	N	C
2-2-14	Puali	Lihue	N	C
2-2-15	Huleia	Lihue	Y	C
2-3-01	Kipu Kai	Lihue	N	C
2-3-02	Waikomo	Koloa	Y	C
2-3-04	Lawai	Koloa	N	C
2-3-06	Wahiawa	Hanapepe	N	C
2-3-07	Hanapepe	Hanapepe	Y	C
2-4-01	Mahinauli	Hanapepe	N	C
2-4-02	Aakukui	Hanapepe	N	I
2-4-03	Waipao	Hanapepe	N	C
2-4-04s	Waimea S.	Kekaha	Y	C
2-5-06	Kinekine Ditch	Kekaha	N	C
2-5-07	Kaawaloa	Kekaha	N	I
2-5-08	Nahomalu	Kekaha	N	I
2-5-09	Kaulaula	Makaha	N	I
2-5-10	Haeleele	Makaha	N	I
2-5-13	Kauhao	Makaha	N	I
2-5-15	Milolii	Makaha	N	C
2-5-16	Nualolo	Makaha	N	C

CODE	STREAM	QUAD	TRIB	CONT/ INT
Oahu				
3-1-03	Paumalu	Waimea	Y	I
3-1-04	Kawela	Kahuku	N	I
3-1-05	Oio	Kahuku	N	I
3-1-06	Malaekahana	Kahuku	N	C
3-1-07	Kahawainui	Kahuku	N	C
3-1-08	Wailele Gl.	Kahuku	N	I
3-1-09	Koloa Gl.	Kahuku	N	C
3-1-10	Kaipapau	Hauula	N	I
3-1-11	Maakua	Hauula	N	I
3-1-13	Kaluanui	Hauula	N	C
3-1-16	Punaluu	Kahana	N	C
3-1-18	Kahana	Kahana	Y	C
3-1-19	Kaaawa	Kahana	N	C
3-1-20	Makaua	Kahana	N	C
3-1-21	Unnamed	Kahana	N	C
3-2-01	Hakipuu	Kahana	N	C
3-2-02	Waikane	Kaneohe	Y	C
3-2-03	Waianu	Kaneohe	N	C
3-2-04	Waiahole	Kaneohe	Y	C
3-2-05	Kaalaea	Kaneohe	N	C
3-2-07s	Kahaluu S.	Kaneohe	Y	C
3-2-08	Heeia	Kaneohe	N	C
3-2-09	Keaahala	Kaneohe	N	C
3-2-10	Kaneohe	Kaneohe	Y	C
3-2-11	Kawa	Kaneohe	N	C
3-2-13	Kawainui/ Maunawili	Mokapu	N	C
3-2-14	Kaelepulu Canal	Mokapu	N	C
3-2-15	Waimanalo	Koko	N	C
3-3-03	Kuliouou	Koko	N	I
3-3-04	Niu	Koko	Y	I
3-3-05	Wailupe	Koko	Y	I
3-3-06	Waialaenui	Honolulu	Y	I
3-3-07s	Ala Wai S.	Honolulu	Y	C
3-3-09	Nuuanu	Honolulu	Y	C
3-3-10	Kapalama	Honolulu	N	C
3-3-11	Kalihi	Honolulu	Y	C
3-3-12	Moanalua	Honolulu	Y	C
3-4-02	Halawa	Puuloa	Y	C
3-4-03	Aiea	Waipahu	N	I
3-4-04	Kalauao	Waipahu	N	C
3-4-05	Waimalu	Waipahu	Y	C
3-4-06	Waiawa	Waipahu	Y	I
3-4-10	Waikele	Waipahu	Y	C
3-4-11	Honouliuli	Ewa	N	I

CODE	STREAM	QUAD	TRIB	CONT/ INT
3-5-01	Nanakuli	Schofield	N	I
3-5-02	Ulehawa	Waianae	N	I
3-5-04	Mailiili	Waianae	N	C
3-5-05	Kaupuni	Waianae	Y	I
3-5-07	Makaha	Waianae	N	I
3-5-08	Makua	Kaena	N	I
3-6-03	Unnamed	Kaena	N	C
3-6-04	Makaleha	Kaena	N	C
3-6-06s	Kiikii S.	Haleiwa	Y	C
3-6-07s	Paukauila S.	Haleiwa	Y	C
3-6-07s	Anahulu S.	Haleiwa	Y	C
3-6-09	Loko Ea	Haleiwa	N	C
3-6-10	Waimea R.	Waimea	Y	C
Molokai				
4-1-01	Waihanau	Kaunakakai	N	I
4-1-02	Waialeia	Kamalo	N	C
4-1-03	Waikolu	Kamalo	N	C
4-1-04	Wainene	Kamalo	N	C
4-1-05	Anapuhi	Kamalo	N	C
4-1-06	Waiohookalo	Kamalo	N	C
4-1-07	Keawanui	Kamalo	N	C
4-1-08	Kailiili	Kamalo	N	C
4-1-09	Pelekunu	Kamalo	Y	C
4-1-10	Waipu	Kamalo	N	I
4-1-11	Haloku	Kamalo	N	I
4-1-12	Oloupena	Kamalo	N	C
4-1-13	Puukaoku	Kamalo	N	I
4-1-14	Wailele	Kamalo	N	I
4-1-15	Wailau	Kamalo	Y	C
4-1-17	Waiahookalo	Halawa	N	C
4-1-18	Kahiwa	Halawa	N	C
4-1-19	Kawainui	Halawa	Y	C
4-1-20	Pipiwai	Halawa	N	C
4-1-21	Halawa	Halawa	Y	C
4-1-22	Hakaaano	Halawa	N	C
4-2-01	Pohakupili	Halawa	N	I
4-2-02	Honoulimaloo	Halawa	N	C
4-2-03	Honouliwai	Halawa	N	C
4-2-04	Waialua	Halawa	N	C
4-2-05	Kainalu	Halawa	N	I
4-2-06	Honomuni	Halawa	N	I
4-2-08	Mapulehu	Halawa	Y	I
4-2-09	Kaluaaha	Kamalo	N	I
4-2-10	Kahananui	Kamalo	N	I

CODE	STREAM	QUAD	TRIB	CONT/INT
4-2-11	Manawai	Kamalo	N	I
4-2-12	Ohia	Kamalo	N	I
4-2-13	Wawaia	Kamalo	N	I
4-2-14	Kamalo	Kamalo	N	I
4-2-15	Kawela	Kaunakakai	N	I
4-2-16	Papio	Halawa	N	C
	Maui			
6-1-01	Ukumehame	Olowalu	Y	I
6-1-02	Olowalu	Olowalu	N	I
6-1-03	Launiupoku	Lahaina	N	I
6-1-04	Kauaula	Lahaina	N	I
6-1-05	Kahoma	Lahaina	Y	I
6-1-06	Wahikuli	Lahaina	Y	I
6-1-07	Honokowai	Lahaina	Y	I
6-1-08	Kahana	Honolua	Y	I
6-1-09	Honokahua	Honolua	N	C
6-1-10	Honolua	Honolua	N	C
6-1-11	Honokohau	Honolua	N	C
6-2-01	Poelua	Kahakuloa	N	I
6-2-02	Honanana	Kahakuloa	N	I
6-2-03	Kahakuloa	Kahakuloa	N	C
6-2-05	Waiolai	Kahakuloa	N	C
6-2-06	Makamakaole	Kahakuloa	N	C
6-2-07	Waihee R.	Wailuku	Y	C
6-2-08	Waiehu	Wailuku	Y	C
6-2-09	Iao	Wailuku	Y	C
6-2-10	Waikapu	Maalaea	N	C
6-3-01	Maliko	Paia	N	I
6-3-02	Kuiaha	Haiku	Y	I
6-3-03	Kaupakulua	Haiku	N	I
6-3-04	Manawaiiao	Haiku	N	I
6-3-05	Uaoa	Haiku	N	I
6-3-07	Kakipi	Haiku	Y	C
6-3-08	Honopou	Haiku	Y	C
6-3-09	Hoolawa	Haiku	Y	C
6-3-10	Waipio	Haiku	N	C
6-3-11	Hanehoi	Haiku	Y	C
6-3-12	Hoalua	Haiku	N	C
6-3-13	Hanawana	Haiku	N	C
6-3-14	Kailua	Keanae	Y	C
6-3-15	Nailiilihaele	Keanae	N	C
6-4-01	Oopuola	Keanae	Y	C
6-4-02	Kaaiea	Keanae	N	C
6-4-03	Kolea	Keanae	N	C
6-4-04	Waikamoi	Keanae	Y	C
6-4-06	Puohokamoa	Keanae	N	C
6-4-07	Haipuaena	Keanae	N	C
6-4-08	Punalau	Keanae	Y	C
6-4-09	Honomanu	Keanae	Y	C
6-4-10	Nuaailua	Keanae	N	C
6-4-11	Piinaau	Keanae	Y	C
6-4-12	Ohia	Keanae	N	C
6-4-13	Waiokamilo	Keanae	N	C
6-4-14	Wailuanui	Keanae	Y	C
6-4-15	W. Wailuaiki	Keanae	N	C
6-4-16	E. Wailuaiki	Keanae	N	C
6-4-17	Kopiliula	Keanae	Y	C
6-4-18	Waiohue Gl.	Nahiku	N	C
6-4-19	Paakea	Nahiku	N	C
6-4-20	Waiaaka	Nahiku	N	C
6-4-21	Kapaula	Nahiku	N	C
6-4-22	Hanawi	Nahiku	N	C
6-4-23	Makapipi	Nahiku	N	C
6-4-24	Kuhiwa	Nahiku	N	C
6-4-25	Waihole	Nahiku	N	C
6-4-26	Manawaikeae	Hana	N	I
6-4-27	Kahawaihapapa	Hana	N	I
6-4-28	Keaaiki	Hana	N	I
6-4-29	Waioni	Hana	N	I
6-4-30	Lanikele	Hana	N	I
6-4-31	Heleleikeoha	Hana	N	C
6-4-32	Kawakoe	Hana	Y	I
6-4-33	Ulaino	Hana	N	I
6-4-34	Kawaipapa	Hana	N	I
6-4-36	Unnamed	Hana	Y	C
6-5-01	Moomoonui	Hana	N	I
6-5-02	Haneoo	Hana	N	I
6-5-03	Kapia	Hana	N	I
6-5-04	Waiohonu	Kipahulu	N	I
6-5-05	Papaahawahawa	Kipahulu	N	I
6-5-06	Alaalaula	Kipahulu	N	C
6-5-07	Wailua	Kipahulu	N	C
6-5-08	Honolewa	Kipahulu	N	C
6-5-09	Waieli	Kipahulu	N	C
6-5-10	Kakiweka	Kipahulu	N	C
6-5-11	Hahalawe	Kipahulu	Y	C
6-5-12	Puaaluu	Kipahulu	N	C
6-5-13	Oheo Gl	Kipahulu	Y	C
6-5-15	Koukouai	Kipahulu	N	I
6-5-16	Opelu	Kipahulu	N	C

CODE	STREAM	QUAD	TRIB	CONT/INT
6-5-17	Kukuiula	Kipahulu	N	C
6-5-18	Kaapahu	Kipahulu	N	C
6-5-19	Lelekea	Kaupo	N	C
6-5-20	Alelele	Kaupo	N	C
6-5-21	Kalepa	Kaupo	N	C
6-5-22	Nuanuaaloa	Kaupo	N	I
6-5-24	Manawainui	Kaupo	Y	I
	Hawaii			
8-1-03	Kumakua	Hawi	N	C
8-1-06	Hanaula	Hawi	N	I
8-1-07	Hapahapai	Hawi	N	I
8-1-08	Pali Akamoa	Hawi	N	I
8-1-09	Wainaia	Hawi	N	I
8-1-10	Unnamed	Hawi	N	I
8-1-11	Halawa	Hawi	N	I
8-1-12	Aamakao	Hawi	N	C
8-1-13	Niulii	Honokane	N	C
8-1-14	Waikama	Honokane	N	C
8-1-15	Pololu	Honokane	Y	C
8-1-16	Honokane Nui	Honokane	N	C
8-1-17	Honokane Iki	Honokane	N	C
8-1-18	Kalele Gl.	Honokane	N	C
8-1-19	Waipahi	Honokane	N	C
8-1-20	Honokea	Honokane	N	C
8-1-21	Kailikaula	Honokane	N	C
8-1-22	Honopue	Honokane	N	C
8-1-23	Kolealiilii	Honokane	Y	C
8-1-24	Ohiahuea	Honokane	N	C
8-1-25	Nakooko	Honokane	N	C
8-1-26	Waiapuka	Honokane	Y	C
8-1-27	Waikaloa	Honokane	N	C
8-1-28	Waimaile	Honokane	N	C
8-1-29	Kukui	Honokane	N	C
8-1-30	Paopao	Honokane	N	C
8-1-31	Waiaalala	Honokane	N	C
8-1-32	Punalulu	Honokane	N	C
8-1-33	Kaimu	Honokane	N	C
8-1-34	Pae	Honokane	N	C
8-1-35	Waimanu	Honokane	Y	C
8-1-36	Pukoa	Honokane	N	C
8-1-37	Manuwaikaalio	Kukuihaele	N	C
8-1-38	Naluea	Kukuihaele	N	C
8-1-39	Kahoopuu	Kukuihaele	N	C
8-1-42	Waipahoehoe	Kukuihaele	N	C

CODE	STREAM	QUAD	TRIB	CONT/INT
8-1-44	Wailoa/Waipio	Kukuihaele	Y	C
8-1-45	Lalakea	Kukuihaele	N	C
8-1-46	Kaluahine Falls	Kukuihaele	N	C
8-1-47	Waiulili	Kukuihaele	N	C
8-1-49	Waipunahoe	Kukuihaele	N	C
8-1-50	Waialeale	Kukuihaele	N	C
8-1-51	Waikoloa	Kukuihaele	N	I
8-1-52	Kapulena	Kukuihaele	N	I
8-1-53	Kawaikalia	Kukuihaele	N	I
8-1-54	Malanahae	Kukuihaele	N	I
8-1-61	Nienie	Honokaa	N	I
8-1-62	Papuaa	Honokaa	N	C
8-1-65	Kahaupu	Honokaa	N	I
8-1-66	Kahawailiili	Honokaa	N	I
8-1-67	Keahua	Honokaa	N	C
8-1-68	Kalopa	Honokaa	N	I
8-1-69	Waikaalulu	Honokaa	N	I
8-1-70	Kukuilamalamahii	Honokaa	N	C
8-1-71	Alilipali	Honokaa	N	I
8-1-73	Kaumoali Gl	Honokaa	N	I
8-1-76	Waipunahina	Honokaa	N	I
8-1-77	Waipunalau Gl	Kukaiau	N	I
8-1-78	Paauilo	Kukaiau	N	I
8-1-79	Aamanu	Kukaiau	N	C
8-1-80	Koholalele Gl	Kukaiau	Y	I
8-1-81	Kalapahapu Gl	Kukaiau	N	I
8-1-82	Kukaiau	Kukaiau	N	I
8-1-85	Kaala	Kukaiau	N	I
8-1-86	Kealakaha	Kukaiau	N	C
8-1-88	Kupapaulua	Kukaiau	N	I
8-1-89	Kaiwiki	Kukaiau	N	C
8-1-90	Kaula	Kukaiau	N	C
8-2-01	Kaohaoha	Kukaiau	N	C
8-2-02	Kaawalii	Kukaiau	N	C
8-2-03	Waipunalei	Keanakolu	N	C
8-2-04	Laupahoehoe	Papaaloa	Y	C
8-2-05	Kilau	Papaaloa	N	C
8-2-06	Manowaiopae	Papaaloa	N	C
8-2-07	Kuwaikahi	Papaaloa	N	C
8-2-08	Kihalani	Papaaloa	N	C
8-2-09	Kaiwilahilahi	Papaaloa	N	C
8-2-10	Haakoa	Papaaloa	Y	C
8-2-11	Pahale	Papaaloa	Y	C
8-2-12	Kapehu	Papaaloa	N	C
8-2-13	Paeohe	Papaaloa	N	C
8-2-14	Maulua	Papaaloa	Y	C

CODE	STREAM	QUAD	TRIB	CONT/ INT
8-2-16	Pohakupuka	Papaaloa	Y	C
8-2-17	Kulanakii	Papaaloa	N	C
8-2-18	Ahole	Papaaloa	N	C
8-2-19	Poupou	Papaaloa	N	C
8-2-20	Manoloa	Papaaloa	N	C
8-2-21	Ninole	Papaaloa	N	C
8-2-22	Kaaheiki	Papaaloa	N	C
8-2-23	Waikolu	Papaaloa	N	C
8-2-24	Waikaumalo	Papaaloa	N	C
8-2-25	Kahuku	Papaaloa	N	C
8-2-26	Waiehu	Papaaloa	N	C
8-2-27	Nanue	Papaaloa	Y	C
8-2-28	Opea	Papaaloa	N	C
8-2-29	Peleau	Papaaloa	N	C
8-2-30	Umauma	Papaaloa	Y	C
8-2-31	Kamaee	Papaaloa	N	C
8-2-32	Hakalau	Papaaloa	Y	C
8-2-33	Kolekole	Papaikou	Y	C
8-2-34	Paheehee	Papaikou	N	C
8-2-35	Honomu	Papaikou	N	C
8-2-36	Laimi	Papaikou	N	C
8-2-37	Kapehu	Papaikou	N	C
8-2-38	Makea	Papaikou	N	C
8-2-39	Alia	Papaikou	N	C
8-2-40	Makahanaloa	Papaikou	N	C

CODE	STREAM	QUAD	TRIB	CONT/ INT
8-2-41	Waimaauou	Papaikou	N	C
8-2-42	Waiaama	Papaikou	N	C
8-2-43	Kawainui	Papaikou	N	C
8-2-44	Onomea	Papaikou	N	C
8-2-45	Alakahi	Papaikou	N	C
8-2-46	Hanawi	Papaikou	N	C
8-2-47	Kalaoa	Papaikou	N	C
8-2-48	Aleamai	Papaikou	N	C
8-2-49	Kaieie	Papaikou	N	C
8-2-50	Puuokalepa	Papaikou	Y	C
8-2-51	Kaapoko	Papaikou	N	C
8-2-52	Papaikou	Papaikou	N	C
8-2-53	Kapue	Papaikou	N	C
8-2-54	Pahoehoe	Papaikou	Y	C
8-2-55	Paukaa	Papaikou	N	C
8-2-56	Honolii	Papaikou	Y	C
8-2-57	Maili	Papaikou	N	C
8-2-59	Pukihae	Hilo	N	C
8-2-60	Wailuku R.	Hilo	Y	C
8-2-61	Wailoa R.	Hilo	Y	C
8-2-62	Kaahakini	Hilo	N	C
8-4-02	Waiaha	Kailua	N	I
8-5-01	Haloa	Kamuela	N	I
8-5-02	Lamimaumau	Kamuela	N	I
8-5-03	Waikoloa	Kamuela	N	I

Table 6 Tributaries with Associated Streams

(Alphabetically by Island)

TRIBUTARY	Tributary name	STREAM	Stream name at mouth
CODE	HSA code; island-hydrographic unit-stream.tributary	CODE	HSA code; island-hydrographic unit stream/system

TRIBUTARY	CODE	STREAM	CODE
Kauai			
Awini		Waimea S.	2-4-04s
Elekeninui		Waimea S.	2-4-04s
Halaulani		Kilauea	2-1-28
Halehaha		Waimea S.	2-4-04s
Halekua		Waimea S.	2-4-04s
Halemanu	2-2-04.05.2	Waimea S.	2-4-04s
Halenanahu		Huleia	2-2-15
Halepaakai		Waimea S.	2-4-04s
Halii		Wailua S.	2-2-08s
Hauhili		Hanapepe	2-3-07
Hiaupe		Wainiha R.	2-1-14
Hoinakauna-lehua		Huleia	2-2-15
Iliiliula		Wailua S.	2-2-08s
Iole		Wailua S.	2-2-08s
Kaalula		Anahola	2-2-01
Kaapoko		Hanalei R.	2-1-19
Kahiliholo		Kilauea	2-1-28
Kahoopulu		Anahola	2-2-01
Kalai		Hanapepe	2-3-07
Kalama	2-2-08.01.1	Wailua S.	2-2-08s
Kalaumakua		Kilauea	2-1-28
Kamooloa		Huleia	2-2-15
Kapahi		Kapaa	2-2-04
Kapohaku-kilomanu		Hanapepe	2-3-07
Kauaikinana		Waimea S.	2-4-04s
Kaulu		Wailua S.	2-2-08s
Kaumoku		Kalihiwai R.	2-1-25
Kaupaku		Anahola	2-2-01
Kawaikoi	2-2-04.06.3	Waimea S.	2-4-04s
Kawaipuua		Hanapepe	2-3-07
Kawi		Wailua S.	2-2-08s
Keahua		Wailua S.	2-2-08s
Kealia	2-2-04.01	Kapaa	2-2-04
Keaoopu		Anahola	2-2-01
Koaie	2-2-04.04	Waimea S.	2-4-04s

TRIBUTARY	CODE	STREAM	CODE
Koholoina		Waimea S.	2-4-04s
Kokee	2-2-04.05.1	Waimea S.	2-4-04s
Konohiki	2-2-06.01	Waikaea Canal	2-2-06
Koula		Hanapepe	2-3-07
Kuia		Huleia	2-2-15
Loli		Waimea S.	2-4-04s
Maheo	2-2-08.02.3	Wailua S.	2-2-08s
Maiakii		Kapaa	2-2-04
Makaleha		Kapaa	2-2-04
Makawea		Wainiha R.	2-1-14
Makaweli	2-2-04.04.1	Waimea S.	2-4-04s
Maluapopoki		Waimea S.	2-4-04s
Mamalahoa		Waioli	2-1-18
Maunahina		Wainiha R.	2-1-14
Mimino		Kapaa	2-2-04
Moalepe		Kapaa	2-2-04
Mohihi	2-2-04.06.1	Waimea S.	2-4-04s
Mokihana	2-2-04.04.2	Waimea S.	2-4-04s
Mokuone		Waimea S.	2-4-04s
Nawaimaka		Waimea S.	2-4-04s
Noe		Waimea S.	2-4-04s
North Fork Wailua	2-2-08.02	Wailua S.	2-2-08s
Olokele	2-2-04.01.3	Waimea S.	2-4-04s
Omao	2-3-02.01	Waikomo	2-3-02
Opaekaa	2-2-08.01	Wailua S.	2-2-08s
Palikea		Wailua S.	2-2-08s
Paohia		Huleia	2-2-15
Papakolea		Huleia	2-2-15
Papuaa		Huleia	2-2-15
Poeleele	2-3-02.02	Waikomo	2-3-02
Pohakuhonu		Kilauea	2-1-28
Poomau	2-2-04.06	Waimea S.	2-4-04s
Pouli		Kalihiwai R.	2-1-25
Puakukui		Huleia	2-2-15
Puhi		Huleia	2-2-15
Puu Ka Ele		Kilauea	2-1-28

TRIBUTARY	CODE	STREAM	CODE
South Fork Wailua	2-2-08.03	Wailua S.	2-2-08s
Uhau Iole		Wailua S.	2-2-08s
Waiahi		Wailua S.	2-2-08s
Waiahulu		Waimea S.	2-4-04s
Waiaka		Wailua S.	2-2-08s
Waiakoali		Waimea S.	2-4-04s
Waialae	2-2-04.03	Waimea S.	2-4-04s
Waianuenue		Waimea S.	2-4-04s
Waiau		Waimea S.	2-4-04s
Waihohonu		Waikomo	2-3-02
Waikoko		Wailua S.	2-2-08s
Wailapa		Kilauea	2-1-28
Wailua R.	2-2-08	Wailua S.	2-2-08s
Waimea R.	2-4-04	Waimea S.	2-4-04s
Wainonoia		Hanapepe	2-3-07
Waipunaea		Hanalei R.	2-1-19
Weoweopilau		Huleia	2-2-15

Oahu

TRIBUTARY	CODE	STREAM	CODE
Ahuimanu	3-2-07.03	Kahaluu S.	3-2-07s
Aihualama		Ala Wai S.	3-3-07s
Ainoni		Kawainui/ Maunawili	3-2-13
Ala Wai Canal	3-3-07	Ala Wai S.	3-3-07s
Anahulu segment	3-6-08	Anahulu S.	3-6-08s
Aolani		Kaneohe	3-2-10
Elehaha		Waimea R.	3-6-10
Helemano	3-6-07.02	Paukauila S.	3-6-07s
Hiu		Kaupuni	3-5-05
Honua		Kaupuni	3-5-05
Hooleinaiwa	3-2-10.02.3	Kaneohe	3-2-10
Kahaluu	3-2-07.02	Kahaluu S.	3-2-07s
Kahaluu segment	3-2-07	Kahaluu S.	3-2-07s
Kahanaiki		Kawainui/ Maunawili	3-2-13
Kahauiki		Moanalua	3-3-12
Kalalula		Kaupuni	3-5-05
Kaleleiki		Paumalu	3-1-03
Kamananui		Waimea R.	3-6-10
Kamanaiki		Kalihi	3-3-11
Kamooalii	3-2-10.02	Kaneohe	3-2-10
Kanaha		Ala Wai S.	3-3-07s
Kanealole		Ala Wai S.	3-3-07s
Kanewai		Kaupuni	3-5-05
Kapakahi		Waialaenui	3-3-06
Kapakahi		Waikele	3-4-10
Kauaopuu		Kaupuni	3-5-05
Kaukonahua	3-6-06.02	Kiikii S.	3-6-06s
Kawa		Kahana	3-1-18
Kawaiiki	3-6-08.03	Anahulu S.	3-6-08s
Kawailoa	3-6-08.01	Anahulu S.	3-6-08s
Kawainui	3-6-08.02	Anahulu S.	3-6-08s
Kawaiwikoele		Waimea R.	3-6-10
Kawiwi		Kaupuni	3-5-05
Kiikii segment	3-6-06	Kiikii S.	3-6-06s
Kipapa	3-4-10.01	Waikele	3-4-10
Kukaki		Kaupuni	3-5-05
Kukui		Wailupe	3-3-05
Kumaipo		Kaupuni	3-5-05
Kuou		Kaneohe	3-2-10
Kupaua		Niu	3-3-04
Luaalaea		Ala Wai S.	3-3-07s
Luluku		Kaneohe	3-2-10
Lulumahu		Nuuanu	3-3-09
Makawao		Kawainui/ Maunawili	3-2-13
Makiki	3-3-07.02	Ala Wai S.	3-3-07s
Makuku		Nuuanu	3-3-09
Manaiki		Moanalua	3-3-12
Manana	3-4-06.02	Waiawa	3-4-06
Manoa	3-3-07.01	Ala Wai S.	3-3-07s
Maunalaha		Ala Wai S.	3-3-07s
Maunawili	3-2-13.01	Kawainui/ Maunawili	3-2-13s
Moleka		Ala Wai S.	3-3-07s
Moole		Nuuanu	3-3-09
Naniuapo		Ala Wai S.	3-3-07s
Niniko		Nuuanu	3-3-09
North Halawa		Halawa	3-4-02
North Kaukonahua	3-6-06.02.2	Kiikii S.	3-6-06s
North Poamoho		Kiikii S.	3-6-06s
Olomana		Kawainui/ Maunawili	3-2-13
Omao		Kawainui/ Maunawili	3-2-13
Opaeula	3-6-07.01	Paukauila S.	3-6-07s

TRIBUTARY	CODE	STREAM	CODE
Palapu	3-2-13.01.1	Kawainui/ Maunawili	3-2-13
Palolo	3-3-07.01.1	Ala Wai S.	3-3-07s
Paukauila segment	3-6-07	Paukauila S.	3-6-07s
Pauoa		Nuuanu	3-3-09
Poamoho	3-6-06.01	Kiikii S.	3-6-06s
Pukele		Ala Wai S.	3-3-07s
Punanaula		Kaupuni	3-5-05
South Halawa		Halawa	3-4-02
South Kaukonahua	3-6-06.02.1	Kiikii S.	3-6-06s
Uwau		Waiahole	3-2-04
Waaloa		Ala Wai S.	3-3-07s
Waiakeakua		Ala Wai S.	3-3-07s
Waianu		Waiahole	3-2-04
Waiau	3-4-05.01	Waimalu	3-4-05
Waihee	3-2-07.01	Kahaluu S.	3-2-07s
Waihi		Ala Wai S.	3-3-07s
Waikakalaua	3-4-10.02	Waikele	3-4-10
Waikeekee		Waikane	3-2-02
Waimano	3-4-06.01	Waiawa	3-4-06
Waiomao		Ala Wai S.	3-3-07s
Waolani		Nuuanu	3-3-09
Molokai			
Hipuapua		Halawa	4-1-21
Kahawaiiki		Wailau	4-1-15
Kapea		Kawainui	4-1-19
Kapuhi		Pelekunu	4-1-09
Kawaiiki		Pelekunu	4-1-09
Kawailena		Pelekunu	4-1-09
Kawainui		Pelekunu	4-1-09
Kawaipaka		Pelekunu	4-1-09
Lanipuni		Pelekunu	4-1-09
Moalua		Halawa	4-1-21
Nawaihulili		Halawa	4-1-21
Pilipililau		Pelekunu	4-1-09
Pulena		Wailau	4-1-15
Punaula		Mapulehu	4-2-08
Uluwini		Ahaino	4-2-07
Waiakeakua		Wailau	4-1-15
Waiokeela		Wailau	4-1-15

TRIBUTARY	CODE	STREAM	CODE
Maui			
Ae		Iao	6-2-09
Alo		Waikamoi	6-4-04
Amalu		Honokowai	6-1-07
East Wailuanui		Wailuanui	6-4-14
Hahakea		Wahikuli	6-1-06
Halona		Kahoma	6-1-05
Healani		Manawainui	6-5-24
Hokuula		Ukumehame	6-1-01
Hoolawaliilii		Hoolawa	6-3-09
Hoolawanui		Hoolawa	6-3-09
Huelo		Hanehoi	6-3-11
Huluhulu-pueo		Waihee R.	6-2-07
Kahakapau Gl.	6-3-01.01	Maliko	6-3-01
Kanaha	6-1-05.01	Kahoma	6-1-05
Kapalaalaea		Kakipi	6-3-07
Kapaloa		Honokowai	6-1-07
Kaulu		Kakipi	6-3-07
Kinihapai		Iao	6-2-09
Koale		Kakipi	6-3-07
Kolea		Punalau	6-4-08
Kuo		Piinaau	6-4-11
Mailepai		Kahana	6-1-08
Makaa		Kakipi	6-3-07
Makanali		Oopuola	6-4-01
Maluhianaiwi		Hahalawe	6-5-11
Mananole		Waihee R.	6-2-07
Mokulehua		Kawakoe	6-4-32
Nakalaloa		Iao	6-2-09
North Waiehu		Waiehu	6-2-08
Oanui		Kailua	6-3-14
Ohia		Kuiaha	6-3-02
Opana	6-3-07.02	Kakipi	6-3-07
Palauhulu		Piinaau	6-4-11
Palikea	6-5-13.02	Oheo Gl.	6-5-13
Papalua	6-3-07.01	Kakipi	6-3-07
Piiloi		Kakipi	6-3-07
Pipiwai	6-5-13.01	Oheo Gl.	6-5-13
Pokakaekane		Piinaau	6-4-11
Poohahoahoa		Iao	6-2-09
Puakaa		Kopiliula	6-4-17
Puniawa		Honopou	6-3-08

TRIBUTARY	CODE	STREAM	CODE
South Waiehu		Waiehu	6-2-08
Uluini		Honomanu	6-4-09
Waihee		Kakipi	6-3-07
West Wailuanui		Wailuanui	6-4-14

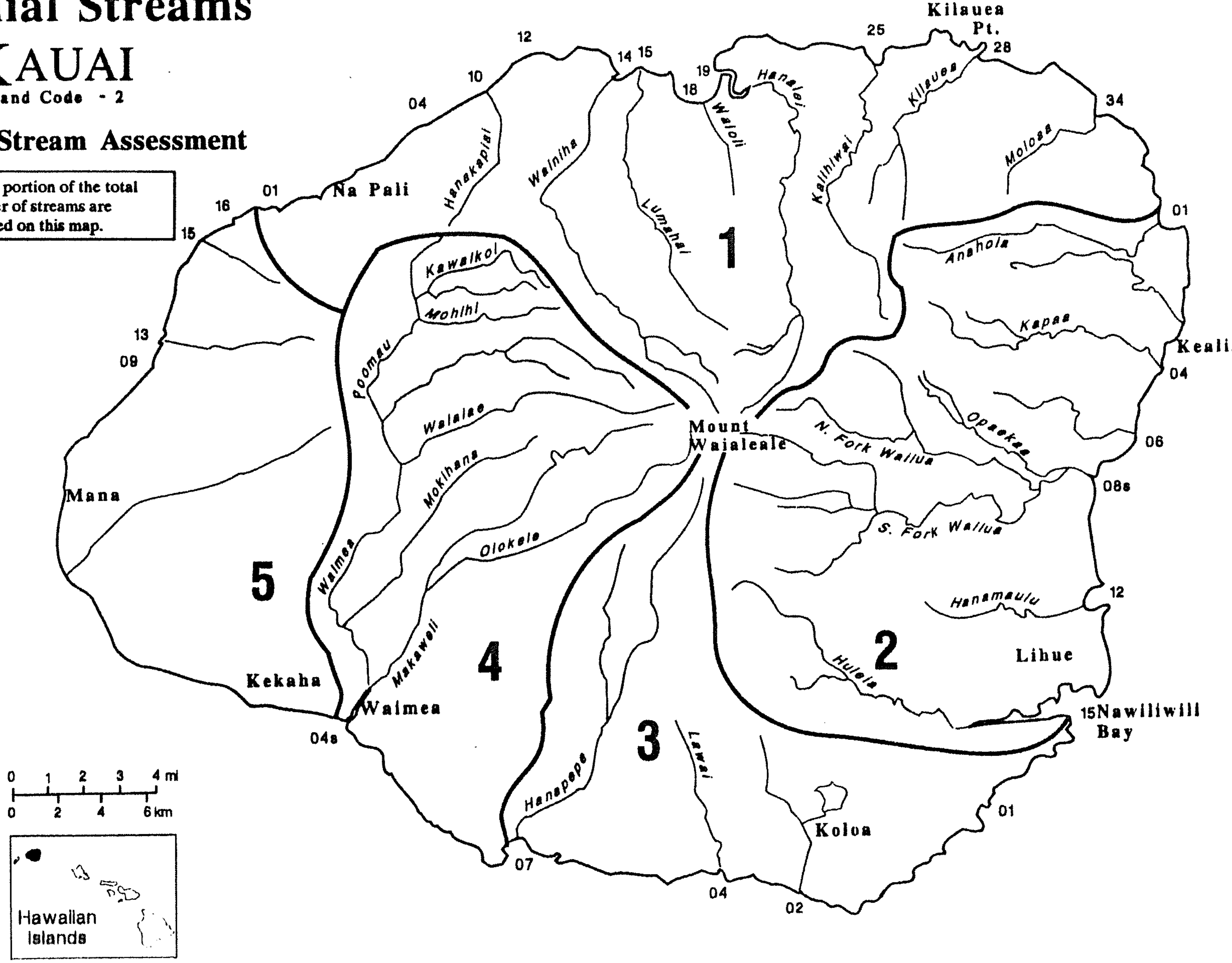
Hawaii

TRIBUTARY	CODE	STREAM	CODE
Aale		Wailuku R.	8-2-60
Ahoa	8-2-10.02	Haakoa	8-2-10
Alakahi		Wailoa/ Waipio	8-1-44
Alenaio	8-2-61.01.1	Wailoa R.	8-2-61
Awehi		Wailuku R.	8-2-60
Hanapueo		Umauma	8-2-30
Hiilawe		Lalakea	8-1-45
Hiilawe		Wailoa/ Waipio	8-1-44
Hookelekele	8-2-60.03	Wailuku R.	8-2-60
Huliilii		Pohakupuka	8-2-16
Kaahakini		Kolekole	8-2-33
Kaahina		Nanue	8-2-27
Kaalau		Pahale	8-2-11
Kahoama		Wailuku R.	8-2-60
Kainehe Gl.	8-1-81.01	Kalapahapu Gl	8-1-81
Kaiwiki		Honolii	8-2-56
Kakaauki		Waimanu	8-1-35
Kalakoo		Kolekole	8-2-33
Kalohewa-hewa		Wailuku R.	8-2-60
Kaluiiki		Wailoa R.	8-2-61
Kamaee		Hakalau	8-2-32
Kamoloumi		Waiapuka	8-1-26
Kaoheanu		Pohakupuka	8-2-16
Kapehu	8-2-60.02	Wailuku R.	8-2-60
Kapili		Laupahoehoe	8-2-04
Kapoloa		Pololu	8-1-15
Kawaiki		Wailoa/ Waipio	8-1-44
Kawaili		Koholalele Gl	8-1-80
Kawainui		Wailoa/ Waipio	8-1-44
Keanuiomano		Waikoloa	8-5-03
Kipi		Wailuku R.	8-2-60
Kohakohau	8-5-03.01	Waikoloa	8-5-03
Koiawe		Wailoa/ Waipio	8-1-44
Kumuawane		Puuokalepa	8-2-50
Laualu		Wailuku R.	8-2-60
Makahiloa		Maulua	8-2-14
Mokupau		Wailuku R.	8-2-60
Nakakauila		Wailuku R.	8-2-60
Nanaue		Wailoa/ Waipio	8-1-44
Oniu		Kolealiilii	8-1-23
Painiu		Nanue	8-2-27
Pakaluahine		Wailuku R.	8-2-60
Pohakupaa		Honolii	8-2-56
Puumaile Gl.	8-1-83.01	Lauhala Gl	8-1-83
Waawaa		Hakalau	8-2-32
Waiakalae		Pololu	8-1-15
Waiakea		Wailoa R.	8-2-61
Waiau		Wailuku R.	8-2-60
Waihilau		Waimanu	8-1-35
Waiilikahi		Waimanu	8-1-35
Waikoana		Pahoehoe	8-2-54
Wailoa		Wailoa/ Waipio	8-1-44
Waima		Wailoa/ Waipio	8-1-44
Wainaku	8-2-60.01	Wailuku R.	8-2-60
Waipahoehoe	8-2-61.01	Wailoa R.	8-2-61

Perennial Streams
KAUAI
Island Code - 2

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.



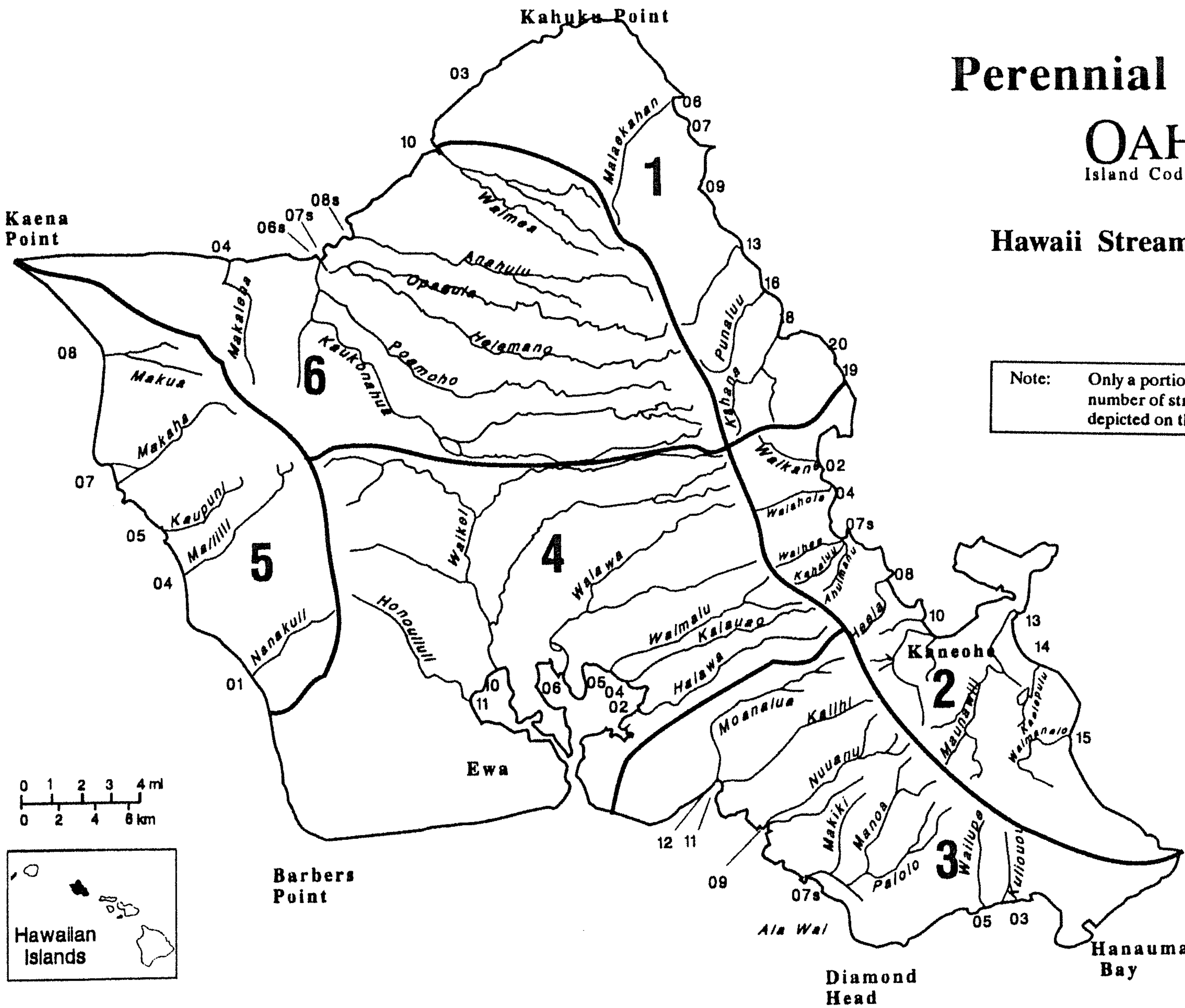
Perennial Streams

OAHU

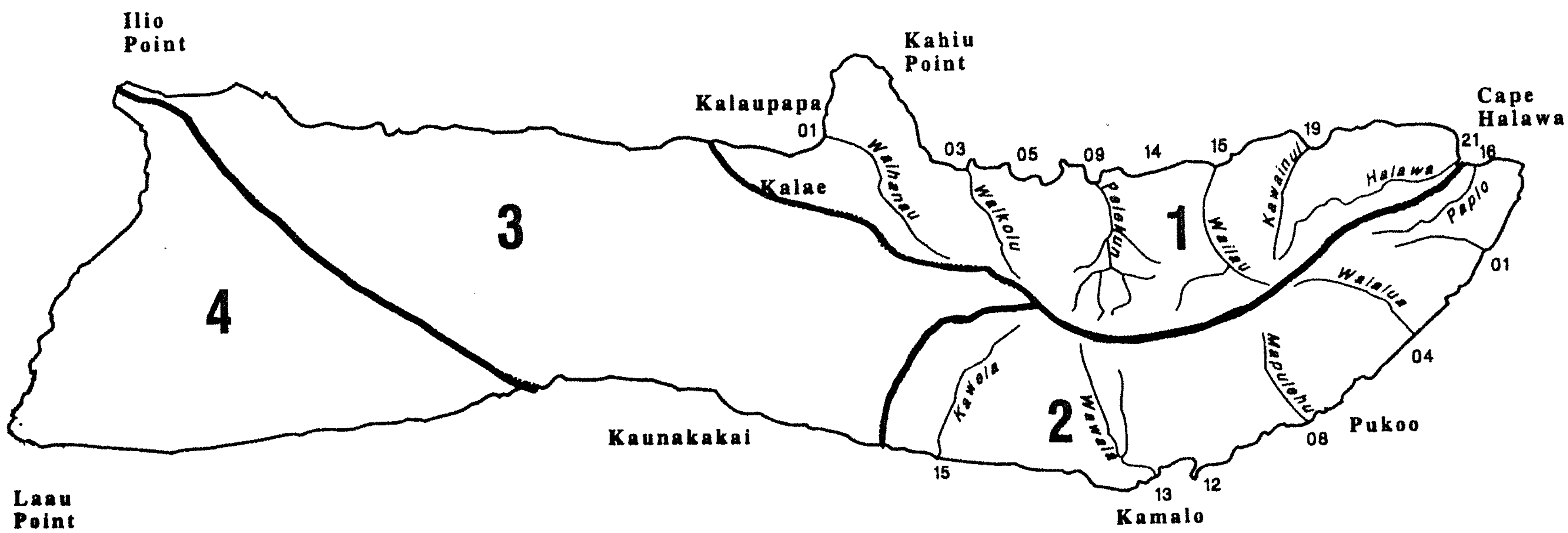
Island Code - 3

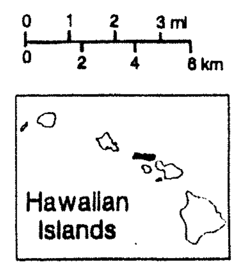
Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.



000063





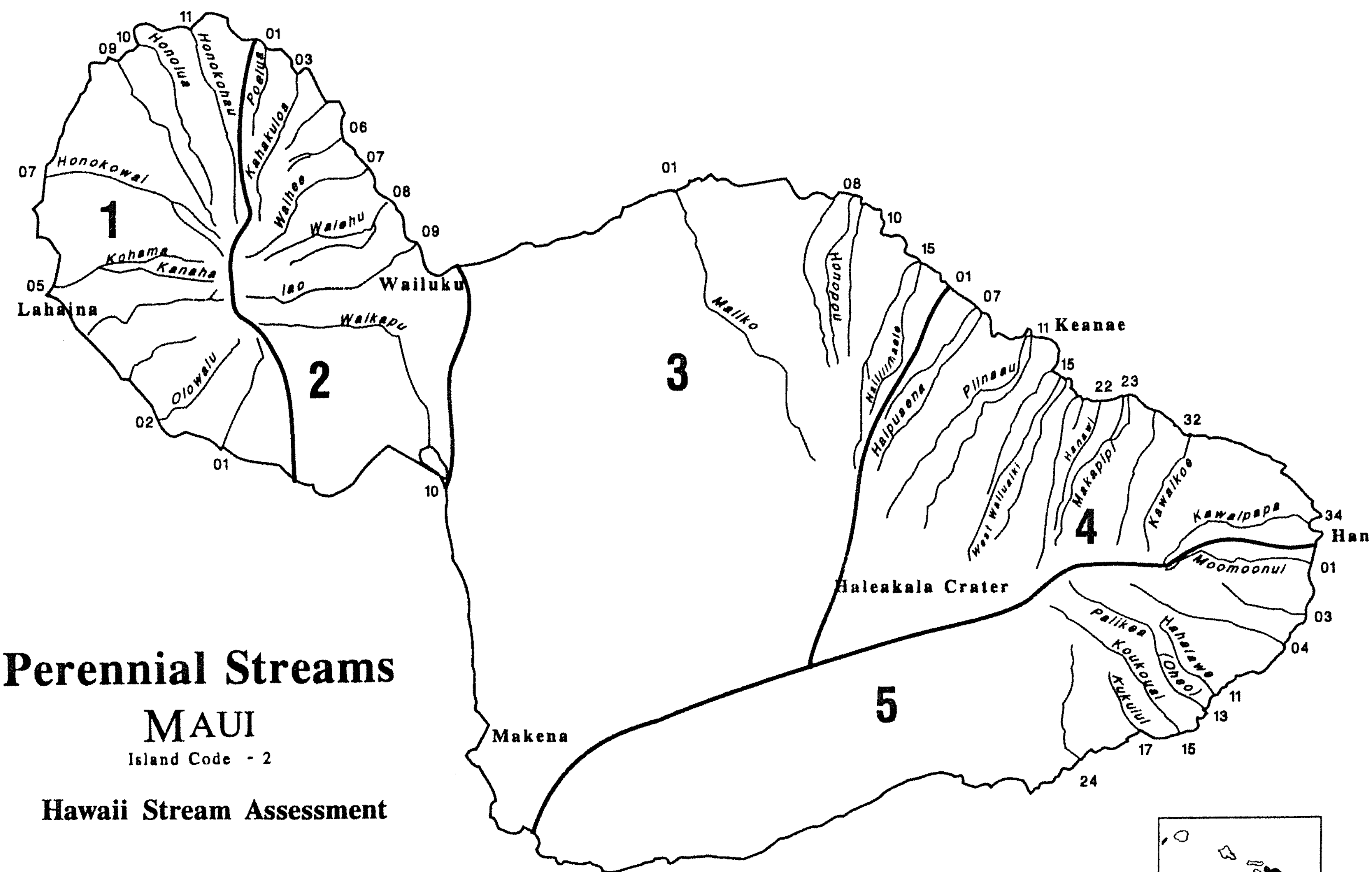
Perennial Streams

MOLOKAI

Island Code - 4

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.



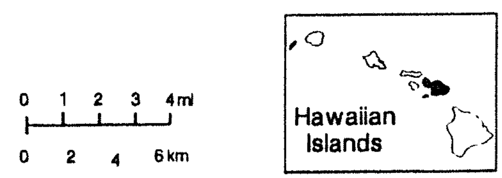
Perennial Streams

MAUI

Island Code - 2

Hawaii Stream Assessment

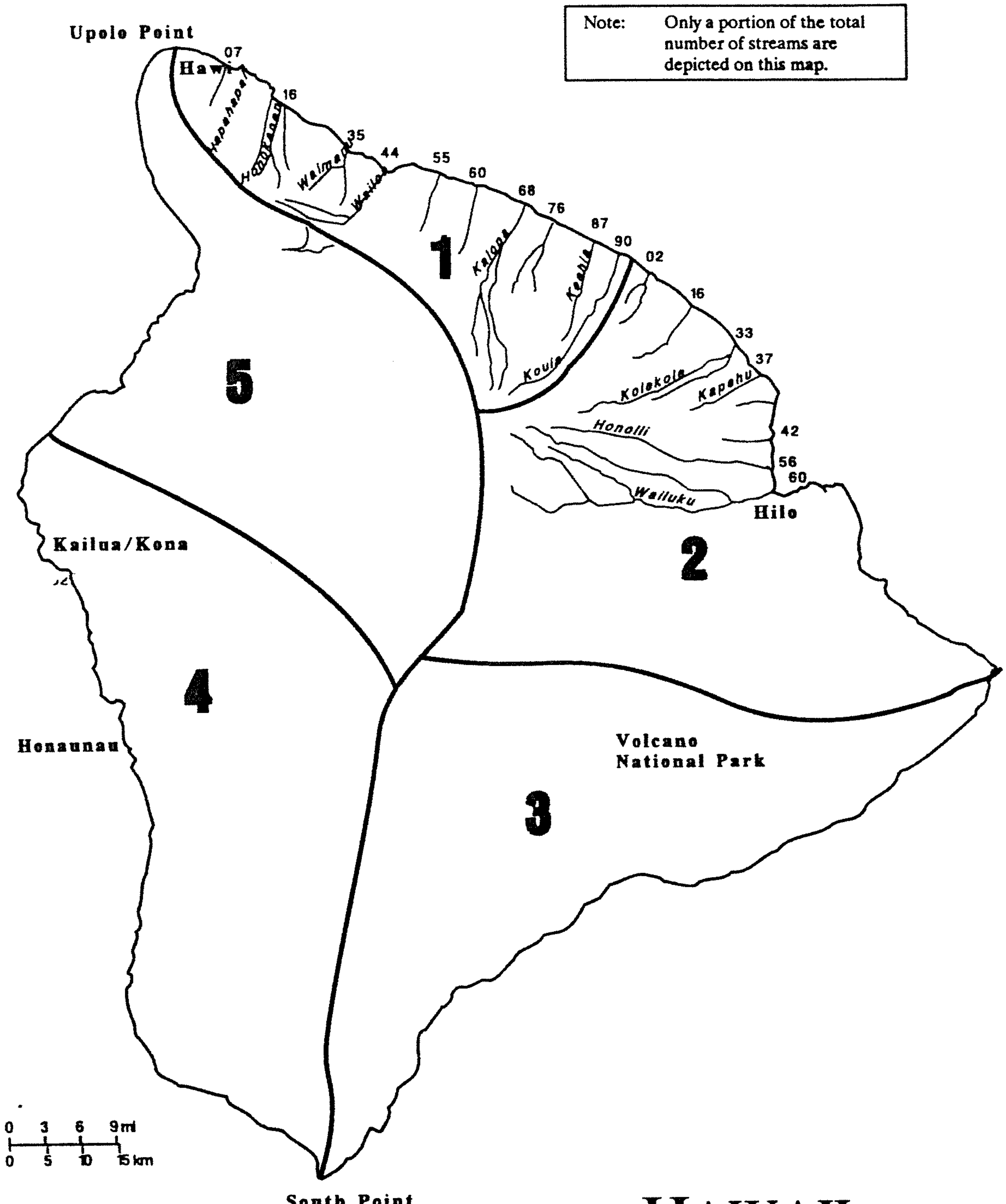
Note:	Only a portion of the total number of streams are depicted on this map.

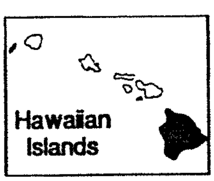


000065

Perennial Streams

Note: Only a portion of the total number of streams are depicted on this map.



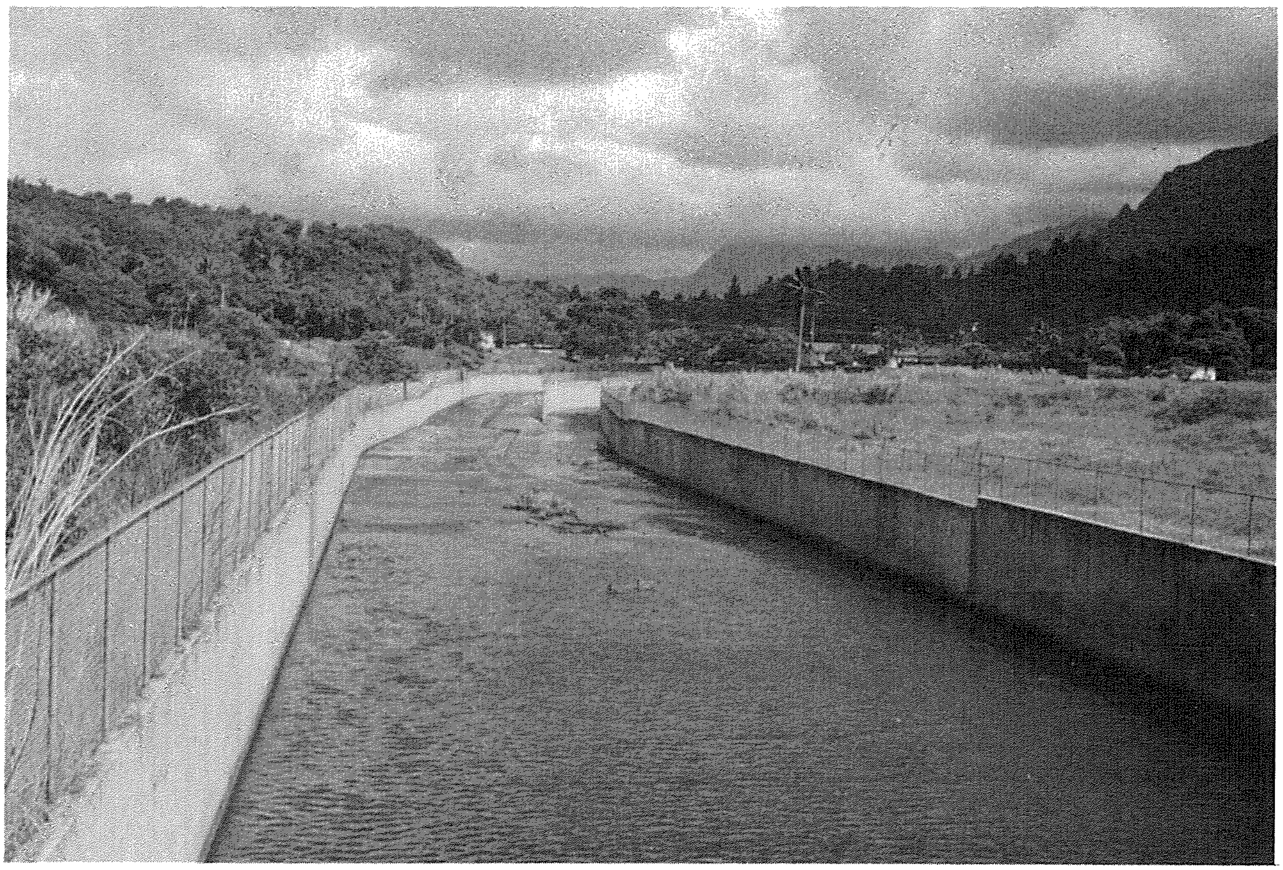


HAWAII

Island Code - 8

Hawaii Stream Assessment

Monitoring and Modifications



Monitoring and Modifications

An inventory of monitoring and modification information is an important step toward understanding streams. Guidance in these areas was provided by a committee and numerous resource experts.

Physical Characteristics Committee
Chair, George Matsumoto, DLNR, DOWALD
Sherrie Samuels, DLNR, DOWALD
Sterling Chow, DLNR, DOWALD
Tom O'Brien, DBED Energy Division
Mary Teves, DOH, Environmental Planning

Monitoring: The availability of information on stream flow and water quality characteristics depends primarily on monitoring. In Hawaii, monitoring of flow is done primarily by stream gaging. About one third of Hawaii's streams have gaging records, although the data must be used with caution. Surface water-quality monitoring records have been identifed by major source and type only.

Modifications: Stream modifications often diminish instream values. It is therefore important to identify the type of stream modification, such as dams, diversions and channelization, and the degree to which it alters the stream. Streams do provide water for many important off stream uses. This subject is discussed briefly in the Water Supply chapter.

The following reports provide some detailed information. Each report is essentially independent and self-contained and represents a consolidation of scientific studies and government documents. Much of the information is scattered, limited and dated. Consequently, the inventories are incomplete. A summary is provided in Table 7.

Table 7 Monitoring and Modifications

(By Island, by Code)

Code	HSA Stream Code	Dam/Div	Dam or Diversion
Name	Stream name at mouth	Y	Dam or diversion weir noted
Monitor	Monitoring information	N	No known dam or diversion weir
G	Gaging information exists	H	Hydroelectric diversion
Q	Water quality information exists	Chan	Channelization Information
		L	Portion of stream is lined

Code	Name	Monitor	Dam/ Div	Chan
Kauai				
2-1-01	Awaawapuhi		N	
2-1-02	Honopu		N	
2-1-03	Nakeikionaiwi		N	
2-1-04	Kalalau	G	N	
2-1-05	Pohakuao		N	
2-1-06	Waiolaa		N	
2-1-07	Hanakoa	G	N	
2-1-08	Waiahuakua		N	
2-1-09	Hoolulu		N	
2-1-10	Hanakapiai	G	N	
2-1-11	Maunapuluo		N	
2-1-12	Limahuli		N	
2-1-13	Manoa		N	
2-1-14	Wainiha R.	GQ	YH	
2-1-15	Lumahai R.	G	N	
2-1-16	Waikoko		N	
2-1-17	Waipa		N	
2-1-18	Waioli	G	N	
2-1-19	Hanalei R.	GQ	Y	
2-1-20	Waileia		N	
2-1-21	Anini		N	
2-1-25	Kalihiwai R.	G	N	
2-1-26	Puukumu	G	N	
2-1-27	Unnamed			
2-1-28	Kilauea	GQ	Y	
2-1-29	Kulihaili		N	
2-1-30	E. Waiakalua		Y	
2-1-31	Pilaa		N	
2-1-32	W. Waipake		N	
2-1-33	E. Waipake		N	
2-1-34	Moloaa		N	
2-1-35	Papaa		N	
2-1-36	Aliomanu		N	
2-2-01	Anahola	GQ	Y	
2-2-02	Kumukumu			
2-2-04	Kapaa	GQ	Y	
2-2-05	Moikeha Canal			
2-2-06	Waikaea Canal	G	Y	
2-2-08s	Wailua S.	G	YH	
2-2-10	Kawailoa			
2-2-12	Hanamaulu		Y	
2-2-13	Nawiliwili			
2-2-14	Puali			
2-2-15	Huleia	GQ	Y	
2-3-01	Kipu Kai		N	
2-3-02	Waikomo			L
2-3-04	Lawai	GQ		
2-3-06	Wahiawa		YH	
2-3-07	Hanapepe	GQ	Y	
2-4-01	Mahinauli			
2-4-02	Aakukui			
2-4-03	Waipao			
2-4-04s	Waimea S.	G	YH	
2-5-06	Kinekine Ditch			
2-5-07	Kaawaloa			
2-5-08	Nahomalu	G	N	
2-5-09	Kaulaula		N	
2-5-10	Haeleele		N	
2-5-13	Kauhao		N	
2-5-15	Milolii		N	
2-5-16	Nualolo		N	

Code	Name	Monitor	Dam/ Div	Chan
Oahu				
3-1-03	Paumalu	G	N	
3-1-04	Kawela			
3-1-05	Oio	G	N	L
3-1-06	Malaekahana	GQ	N	
3-1-07	Kahawainui	G	N	L
3-1-08	Wailele Gl.			
3-1-09	Koloa Gl.	G	N	
3-1-10	Kaipapau		N	
3-1-11	Maakua		N	
3-1-13	Kaluanui	GQ	N	
3-1-16	Punaluu	GQ	Y	L
3-1-18	Kahana	GQ	N	
3-1-19	Kaaawa		N	
3-1-20	Makaua	G	N	
3-1-21	Unnamed		N	
3-2-01	Hakipuu		Y	
3-2-02	Waikane	GQ	Y	
3-2-03	Unnamed		Y	L
3-2-04	Waiahole	G	Y	
3-2-05	Kaalaea		N	
3-2-07s	Kahaluu S.	G	Y	L
3-2-08	Heeia	GQ		L
3-2-09	Keaahala	G		L
3-2-10	Kaneohe	GQ	Y	L
3-2-11	Kawa	G		L
3-2-13	Kawainui/Maunawili	GQ	Y	
3-2-14	Kaelepulu Canal	GQ		
3-2-15	Waimanalo	GQ	Y	L
3-3-03	Kuliouou	G	N	L
3-3-04	Niu		N	L
3-3-05	Wailupe	G	N	
3-3-06	Waialaenui	G	N	L
3-3-07s	Ala Wai S.	G	Y	L
3-3-09	Nuuanu	GQ	Y	L
3-3-10	Kapalama			L
3-3-11	Kalihi	GQ		L
3-3-12	Moanalua	GQ		L
3-4-02	Halawa	GQ	Y	L
3-4-03	Aiea			L

Code	Name	Monitor	Dam/ Div	Chan
3-4-04	Kalauao	GQ	Y	
3-4-05	Waimalu	GQ		L
3-4-06	Waiawa	GQ	Y	
3-4-10	Waikele	GQ	Y	
3-4-11	Honouliuli	G	Y	
3-5-01	Nanakuli	G	N	L
3-5-02	Ulehawa		N	L
3-5-04	Mailiili	G	N	L
3-5-05	Kaupuni	GQ	Y	L
3-5-07	Makaha	GQ	Y	L
3-5-08	Makua	G	N	
3-6-03	Unnamed			
3-6-04	Makaleha	G	N	
3-6-06s	Kiikii S.	G	Y	
3-6-07s	Paukauila S.	G	Y	
3-6-08s	Anahulu S.	G	Y	
3-6-09	Loko Ea		N	
3-6-10	Waimea R.	GQ	N	
Molokai				
4-1-01	Waihanau		N	
4-1-02	Waialeia		N	
4-1-03	Waikolu	G	Y	
4-1-04	Wainene		N	
4-1-05	Anapuhi		N	
4-1-06	Waiohookalo		N	
4-1-07	Keawanui		N	
4-1-08	Kailiili		N	
4-1-09	Pelekunu	GQ	N	
4-1-10	Waipu		N	
4-1-11	Haloku		N	
4-1-12	Oloupena		N	
4-1-13	Puukaoku		N	
4-1-14	Wailele		N	
4-1-15	Wailau	G	N	
4-1-17	Waiahookalo		N	
4-1-18	Kahiwa		N	
4-1-19	Kawainui	GQ	N	
4-1-20	Pipiwai		N	
4-1-21	Halawa	GQ	N	

Code	Name	Moni tor	Dam/ Div	Chan
4-1-22	Hakaaano		N	
4-2-01	Pohakupili	G	N	
4-2-02	Honoulimaloo		N	
4-2-03	Honouliwai		N	
4-2-04	Waialua		N	
4-2-05	Kainalu		N	
4-2-06	Honomuni		N	
4-2-08	Mapulehu	GQ	N	
4-2-09	Kaluaaha		N	
4-2-10	Kahananui		N	
4-2-11	Manawai		N	
4-2-12	Ohia		N	
4-2-13	Wawaia		N	
4-2-14	Kamalo	G	N	
4-2-15	Kawela	GQ	N	
4-2-16	Papio	GQ	N	
Maui				
6-1-01	Ukumehame	G	N	
6-1-01	Ukumehame	G	N	
6-1-02	Olowalu	GQ	Y	
6-1-03	Launiupoku	G	Y	
6-1-04	Kauaula	G	YH	L
6-1-05	Kahoma	GQ	Y	L
6-1-06	Wahikuli			
6-1-07	Honokowai	G	Y	L
6-1-08	Kahana		Y	
6-1-09	Honokahua		Y	
6-1-10	Honolua	G	Y	
6-1-11	Honokohau	GQ	Y	
6-2-01	Poelua	G	N	
6-2-02	Honanana		N	
6-2-03	Kahakuloa	GQ	N	
6-2-05	Waiolai		N	
6-2-06	Makamakaole	G	Y	
6-2-07	Waihee R.	GQ	Y	
6-2-08	Waiehu	G	Y	
6-2-09	Iao	GQ	Y	L
6-2-10	Waikapu	G	Y	
6-3-01	Maliko	G	Y	

Code	Name	Moni tor	Dam/ Div	Chan
6-3-02	Kuiaha		Y	L
6-3-03	Kaupakulua	G	Y	
6-3-04	Manawaiiao			
6-3-05	Uaoa		Y	
6-3-07	Kakipi	G	Y	
6-3-08	Honopou	GQ	Y	
6-3-09	Hoolawa	G	Y	
6-3-10	Waipio		Y	
6-3-11	Hanehoi		Y	
6-3-12	Hoalua		Y	
6-3-13	Hanawana		Y	
6-3-14	Kailua	G	Y	
6-3-15	Nailiilihaele	GQ	Y	
6-4-01	Oopuola	G	Y	
6-4-02	Kaaiea		Y	
6-4-03	Kolea		Y	
6-4-04	Waikamoi	GQ	Y	
6-4-06	Puohokamoa	G	Y	
6-4-07	Haipuaena	GQ	Y	
6-4-08	Punalau		Y	
6-4-09	Honomanu	G	Y	
6-4-10	Nuaailua		Y	
6-4-11	Piinaau	G	Y	
6-4-12	Ohia		Y	
6-4-13	Waiokamilo		Y	
6-4-14	Wailuanui	G	Y	
6-4-15	W. Wailuaiki	GQ	Y	
6-4-16	E. Wailuaiki	G	Y	
6-4-17	Kopiliula	G	Y	
6-4-18	Waiohue Gl.	G	Y	
6-4-19	Paakea	G	Y	
6-4-20	Waiaaka	G	Y	
6-4-21	Kapaula	G	Y	
6-4-22	Hanawi	GQ	Y	
6-4-23	Makapipi	G	Y	
6-4-24	Kuhiwa		N	
6-4-25	Waihole		N	
6-4-26	Manawaikeae		N	
6-4-27	Kahawaihapapa			
6-4-28	Keaaiki		N	
6-4-29	Waioni		N	

Code	Name	Moni tor	Dam/ Div	Chan
6-4-30	Lanikele		N	
6-4-31	Heleleikeoha		N	
6-4-32	Kawakoe			
6-4-33	Ulaino		Y	
6-4-34	Kawaipapa	G	Y	
6-4-36	Unnamed			
6-5-01	Moomoonui	G	N	
6-5-02	Haneoo		N	
6-5-03	Kapia		N	
6-5-04	Waiohonu		N	
6-5-05	Papaahawahawa		N	
6-5-06	Alaalaula		N	
6-5-07	Wailua		N	
6-5-08	Honolewa		N	
6-5-09	Waieli		N	
6-5-10	Kakiweka		N	
6-5-11	Hahalawe	G	N	
6-5-12	Puaaluu		N	
6-5-13	Oheo Gl	GQ	N	
6-5-15	Koukouai		N	
6-5-16	Opelu		N	
6-5-17	Kukuiula	G	N	
6-5-18	Kaapahu		N	
6-5-19	Lelekea		N	
6-5-20	Alelele		N	
6-5-21	Kalepa		N	
6-5-22	Nuanuaaloa		N	
6-5-24	Manawainui		N	
	Hawaii			
8-1-03	Kumakua			
8-1-06	Hanaula			
8-1-07	Hapahapai	G		
8-1-08	Pali Akamoa			
8-1-09	Wainaia			
8-1-10	Unnamed			
8-1-11	Halawa			
8-1-12	Aamakao			
8-1-13	Niulii			

Code	Name	Moni tor	Dam/ Div	Chan
8-1-14	Waikama			
8-1-15	Pololu			
8-1-16	Honokane Nui	G	Y	
8-1-17	Honokane Iki	G	Y	
8-1-18	Kalele Gl.		Y	
8-1-19	Waipahi		Y	
8-1-20	Honokea		Y	
8-1-21	Kailikaula		Y	
8-1-22	Honopue		Y	
8-1-23	Kolealiilii		Y	
8-1-24	Ohiahuea		Y	
8-1-25	Nakooko		Y	
8-1-26	Waiapuka		Y	
8-1-27	Waikaloa		Y	
8-1-28	Waimaile			
8-1-29	Kukui	G	N	
8-1-30	Paopao	G	N	
8-1-31	Waiaalala	G	N	
8-1-32	Punalulu	G	N	
8-1-33	Kaimu	G	N	
8-1-34	Pae		N	
8-1-35	Waimanu	G	N	
8-1-36	Pukoa		N	
8-1-37	Manuwaikaalio			
8-1-38	Naluea			
8-1-39	Kahoopuu			
8-1-42	Waipahoehoe			
8-1-44	Wailoa/Waipio	G	Y	
8-1-45	Lalakea		Y	
8-1-46	Kaluahine Falls			
8-1-47	Waiulili			
8-1-49	Waipunahoe			
8-1-50	Waialeale			
8-1-51	Waikoloa	Q		
8-1-52	Kapulena			
8-1-53	Kawaikalia			
8-1-54	Malanahae			
8-1-61	Nienie			
8-1-62	Papuaa		Y	
8-1-65	Kahaupu			
8-1-66	Kahawailiili			

Code	Name	Monitor	Dam/ Div	Chan
8-1-67	Keahua			
8-1-68	Kalopa			
8-1-69	Waikaalulu			
8-1-70	Kukuilamalamahii			
8-1-71	Alilipali			
8-1-73	Kaumoali Gl			
8-1-76	Waipunahina			
8-1-77	Waipunalau Gl		N	
8-1-78	Paauilo		N	
8-1-79	Aamanu		N	
8-1-80	Koholalele Gl		N	
8-1-81	Kalapahapu Gl		N	
8-1-82	Kukaiau		N	
8-1-85	Kaala		N	
8-1-86	Kealakaha		N	
8-1-88	Kupapaulua		N	
8-1-89	Kaiwiki		N	
8-1-90	Kaula		N	
8-2-01	Kaohaoha		N	
8-2-02	Kaawalii		N	
8-2-03	Waipunalei		N	
8-2-04	Laupahoehoe		N	
8-2-05	Kilau		N	
8-2-06	Manowaiopae	GQ	N	
8-2-07	Kuwaikahi		N	
8-2-08	Kihalani		N	
8-2-09	Kaiwilahilahi		N	
8-2-10	Haakoa		N	
8-2-11	Pahale		N	
8-2-12	Kapehu		N	
8-2-13	Paeohe		N	
8-2-14	Maulua		N	
8-2-16	Pohakupuka	GQ	N	
8-2-17	Kulanakii		N	
8-2-18	Ahole		N	
8-2-19	Poupou		N	
8-2-20	Manoloa		N	
8-2-21	Ninole		N	
8-2-22	Kaaheiki		N	
8-2-23	Waikolu		N	
8-2-24	Waikaumalo		N	

Code	Name	Monitor	Dam/ Div	Chan
8-2-25	Kahuku		N	
8-2-26	Waiehu		N	
8-2-27	Nanue		N	
8-2-28	Opea		N	
8-2-29	Peleau		N	
8-2-30	Umauma		N	
8-2-31	Kamaee		N	
8-2-32	Hakalau	Q	N	
8-2-33	Kolekole	Q	N	
8-2-34	Paheehee		N	
8-2-35	Honomu		N	
8-2-36	Laimi		N	
8-2-37	Kapehu	G	N	
8-2-38	Makea		N	
8-2-39	Alia	GQ	N	
8-2-40	Makahanaloa		N	
8-2-41	Waimaauou		N	
8-2-42	Waiaama		Y	
8-2-43	Kawainui		Y	
8-2-44	Onomea		N	
8-2-45	Alakahi	Q	Y	
8-2-46	Hanawi		N	
8-2-47	Kalaoa	G	N	
8-2-48	Aleamai		N	
8-2-49	Kaieie		NH	
8-2-50	Puuokalepa			
8-2-51	Kaapoko		N	
8-2-52	Papaikou		N	
8-2-53	Kapue		N	
8-2-54	Pahoehoe		N	
8-2-55	Paukaa		N	
8-2-56	Honolii	GQ	N	
8-2-57	Maili		N	
8-2-59	Pukihae		N	
8-2-60	Wailuku R.	GQ	YH	
8-2-61	Wailoa R.	G	Y	L
8-2-62	Kaahakini			
8-4-02	Waiaha	GQ		
8-5-01	Haloa			
8-5-02	Lamimaumau		Y	L
8-5-03	Waikoloa	G		

Gaging

The United States Geological Survey (USGS) is the only government agency that gages surface water in Hawaii. Except for seven index stations and five flood stations, funding for all stations is on a 50-50 cooperative basis between USGS and another government agency, such as DLNR, or the counties. The USGS gaging program is professionally staffed and conforms to national standards. Private sector gaging in Hawaii is limited, is not well documented, and reliability is not assured, and for these reasons is not referenced.

The USGS monitors Hawaii's streams as indicators and predictors of climatic change, to assist in water resource and water quality management and for flood control purposes. Besides monitoring streams, the USGS has gaged most of Hawaii's major irrigation systems, or ditches.

Data provided by the USGS refer to measurements at the point of the gaging station only. These figures may not always be the most appropriate indicators of stream size or general stream characteristics. In no case should the information presented here substitute for specific analysis on a stream by stream basis.

Background

The USGS surface water gaging program began in Hawaii with the

> ...establishment of 12 gaging stations in 1909. These first stations were operated primarily to evaluate the potential of the streams for supplying the irrigation needs of the sugar industry. From this modest beginning, the program rapidly expanded to the point where, in 1914, the USGS operated 87 gaging stations in the State. By 1968, the USGS was operating 240 daily flow surface-water gaging stations, the highest number of stations ever operated by the Hawaii District.
>
> Between 1968 and 1983, there was a net reduction of 116 continuous stream gages... Decisions to drop the gages were based on various economic, technical and political reasons (USGS 1985).

The USGS currently funds a basic network of "index stations" which includes a hydrologic Benchmark station and six NASQAN stations where continuous flow and water quality information is collected.

The location of a gaging station is determined by the purpose of the monitoring program. For example, in Hawaii a primary purpose was to monitor or assess the potential for off-stream use of stream water. Stations established for this purpose were usually placed at existing or proposed diversions.

Types of information: There are several types of gaging stations, including continuous and partial record stations. Continuous gaging stations keep a constant record of discharge. From this, average and median discharge values can be derived. Hawaii's streams typically have a somewhat unique flow characteristic in that it includes very large peak flows, and therefore the average discharge values are not necessarily an accurate measure of the available water during normal times. Median flows (flow exceeded 50 percent of time) is a more accurate measure of typical instream conditions. Partial record gaging stations record the extremes only, peak and/or low flows.

The type of information (low, peak, continuous flow) collected is also determined by the purpose of the monitoring program. For instance, low flow information may be of particular importance for climatic monitoring and for aquatic habitat requirement analysis. Hourly flow records may also be important to the aquatic biologist. Peak flow information is critical for flood control project design. Average and median (discharge which is exceeded 50 percent of the time) flows are important for irrigation and storage purposes.

The USGS provides auxiliary information along with each gage discharge record. This information is essential for a full understanding and interpretation of discharge figures. Remarks are often included in the record that address the quality of the records, existence of upstream diversions, and whether water quality information is available.

Methods

The Hawaii Stream Assessment has relied solely on the United States Geological Survey for its gaging information. In a few cases, the HSA calculated the average and median flow of the mainstem by combining the tributary figures. USGS data reside in various published and unpublished documents and in computer data files. Most discharge information included here is from the USGS Water Resources Data, water years 1970, 1979, 1987, and summary of years prior to 1950. Median discharge figures are from the computer data files.

For each perennial stream or ditch with over five years of continuous gaging information exists, the following information was recorded in the HSA database: gage number; date of annual report used as reference, number of years of record; quality of records; average discharge in cubic feet per second; median flow in cubic feet per second; drainage area above gage measured in square miles; presence or absence of diversion above gage; whether measurement is on a ditch or stream; USGS collected water quality data; gage is active in 1989; water quality data collection active in 1989.

The USGS has determined that it is not possible to predict with any meaningful accuracy the median or low flow discharge characteristics of an ungaged stream in Hawaii by correlation method, which uses adjacent and similar stream gage information;

or by regression analysis, which is an indirect, statistical method of calculating discharge. Therefore, discharge estimates of ungaged streams made by other agencies, while carefully considered, are not referenced in this report.

Results

One hundred and thirty-nine of Hawaii's perennial streams have been gaged at some time or another since the start of the gaging program in 1909. In 1989, 97 streams were gaged, at about 125 stations. Of these, 86 are continuous gage stations. Seven ditches are currently gaged (Table 8).

Stream Size: The size of a stream is an important criterion used in many planning classifications and protection decisions. A number of different criteria or combination thereof can be used to suggest size, e.g., overall length, stream flow, area of watershed.

Length information is inconsistent and unreliable. The U.S. Army Corp of Engineers prepared maps of stream segments thought to have an average flow of at least 5 cfs. While recognizing the deficiencies in the measurement strategy, estimates of those lengths can be useful in providing a rough framework of comparative size. Using the COE maps, there are 28 streams that have a length of ten miles or more.

Code	Name	Total	Main Stem
3-6-06	Kiikii	60.41	
2-2-08	Wailua R.	59.02	
2-4-04	Wailua R.	44.68	19.88
8-1-44	Waimea S.	44.01	11.10
3-6-07	Waipio	41.35	
8-2-60	Paukauila	35.07	7.60
3-4-10	Wailuku R.	33.62	19.97
2-1-19	Waikele	26.39	14.58
8-2-32	Hanalei R.	22.50	10.60
8-2-30	Umauma	21.30	10.10
2-2-15	Huleia	20.74	14.67
2-3-07	Hanapepe	20.69	13.54
3-6-08	Anahulu R.	19.73	14.22
2-1-14	Wainiha R.	18.65	13.25
8-2-56	Honolii	18.10	14.50
8-2-43	Kawainui	17.90	9.70
8-2-33	Kolekole	17.30	10.10
3-4-06	Waiawa	15.62	11.22
6-3-07	Kakipi	15.10	10.60
6-4-11	Piinau	13.10	5.40
8-2-24	Waikaumalo	12.30	7.00
2-1-28	Kilauea	12.04	8.04
8-2-14	Maulua	12.00	4.00
2-1-15	Lumahai R.	11.24	8.99
8-2-27	Nanue	10.88	7.90
2-3-06	Wahiawa	10.03	10.03
2-1-25	Kalihiwui R.		10.03
8-2-53	Kapue		12.70

The HSA relied on stream discharge as the determinant of size. Such information is available for only about a hundred of Hawaii's 376 streams. For purposes of comparing stream size, those 101 streams with continuous gaging records were categorized by size based on largest median and average discharge recorded at any gaging station on the stream.

The only Waimanu (8-1-35) gage is on a tributary, but that stream is likely to be in the medium range. Private gaging indicates the Waihee streams is probably among the large streams. Ungaged streams suggested by COE to have large flows are:

Maile (8-2-57), Kawainiu (8-2-43), Hakalau (8-2-32), Kolekole (8-2-33), Umauma (8-2-30), Pokakupuka (8-2-16), Kapehu (8-2-12), Kaula (8-1-90)

HSA Criteria for Size Categorization of Hawaii's Gaged Perennial Streams
in cubic feet per second (cfs)

Large streams - Median flows greater than or equal to 50 cfs or average flows greater than or equal to 80 cfs.

Medium streams - Median flows between 10 and 50 cfs or average flows between 20 and 80 cfs.

Small streams - Median flows less than or equal to 10 cfs or average flows less than or equal to 20 cfs.

Among the gaged streams, median and average discharge values clustered into somewhat distinct categories, with a disproportionate number of small streams and very few large ones. Using this method, Hawaii gaged streams include 11 large streams, 36 medium and 56 small ones (Table 9).

Discussion

Discharge figures should be used with extreme caution. The USGS monitoring program in Hawaii was and is not designed to determine general stream characteristics or to calculate instream flow. Therefore using data from stations located above a diversion, on a tributary, old records or records prior to diversion, will likely give an inaccurate picture of instream flow. Using this sometimes inappropriate or inadequate data to estimate instream flow or arrive at relative stream size has obvious drawbacks. On the other hand, it is the only standardized measurement available, and until more appropriate data is collected, can serve as a starting point for stream size determination.

Two estimates of stream length are available. The 1978 Army Corps of Engineers Headwater Survey and Maps study combined length and flow to arrive at size estimates. The 1978 Timbol and Maciolek report estimated total length of the perennial sections of channelized streams. These studies had limitations such that no attempt was made to categorize streams by length. However, the information is provided in the database.

Future Research

It may be time to re-evaluate the surface water monitoring program in Hawaii in light of the 1987 Water Code. Besides needing flow information for management purposes, surface water may be the single most reliable indicator and predictor of climate change.

Considering prediction of global climatic changes, expanded monitoring for this purpose might be a priority. This may be facilitated possibly through the USGS Network Analysis program.

Data are not cheap. In 1989, it cost around $25,000 to install a new station. To run it cost around $6,500 a year. Participation by all agencies with monitoring and management responsibility may maximize the monitoring dollar.

Both the State of Hawaii and the USGS are developing computerized Geographic Information System, (GIS) capability and are compatible in their choice of ARC-INFO program. GIS is considered by many to be an ideal tool for managing water resources.

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Table 8 Gaging Records

(By Island, by Code)

CODE	Gage is associated with stream with this HSA code	QUAL DATA	USGS assessment of quality of records
NAME	USGS Station Name	DRAIN	Drainage area above gage (sq. mi.)
GAGE #	USGS number of gage station. If all zeros, median and average are calculated flows.	DIV	Diversions per USGS
		Y	Diversion is present above gage
		N	No diversion is present above gage
		D	Gage is on a ditch
ACT-IVE	A - Active in January, 1991	TYPE DATA	Type of data collected
MED-IAN	Flow at gaging station exceeded 50% of time in cubic feet/second (cfs)	C	Continuous record
		E	Extreme flows only, low and/or peak
		C-E	Converted from continuous to extreme
AVE-RAGE	Average of yearly mean flow in cubic feet/second (cfs) at gaging station	L	Low flow
		P	Peak flow
YRS REC	Years of record, 19..-19..	new	New gage 1988 - continuous record

Note: cfs x 0.646 = MGD

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
Kauai										
2-1-04	Kalalau Str. nr Hanalei	117000		5.2	6.89	31-55			N	C
2-1-07	Hanakoa Str. nr Hanalei	116000		1.8	5.51	31-52			N	C
2-1-10	Hanakapiai Str. nr Hanalei	115000		8.4	16.90	31-52			N	C
2-1-14	Wainiha R. nr Hanalei	108000	A	79.0	138.00	52-	G	10.20	N	C
2-1-14	Wainiha Canal at intake nr Wainiha	110000				10-16				E
2-1-14	Wainiha R. nr Wainiha	113000				12-16			N	E
2-1-15	Lumahai R. nr Hanalei	106000		67.0	117.00	14-33		7.50	N	C
2-1-18	Waioli Str. nr Hanalei	105000		20.0	31.60	14-33			N	C
2-1-19	Hanalei Ditch Kilauea	099500				56-62			D	C
2-1-19	Hanalei Tunnel outlet nr Lihue	100000		28.0	27.30	32-85	G		D	C
2-1-19	Hanalei at alt. 625 ft nr Hanalei	101000		49.0	83.40	14-55			Y	C
2-1-19	Combined records of sttaions 16100000, 16101000	101003		68.0		32-55			N	C
2-1-19	China Ditch nr Hanalei	102000		29.0	27.20	11-80			D	C-L
2-1-19	Hanalei R. nr Hanalei	103000	A	130.0	212.00	12-	G	19.10	Y	C
2-1-19	Kuna Ditch nr Hanalei	104000				12-19			D	E
2-1-19	Hanalei R. at Hwy 56 bridge nr Hanalei	104200	A			62-			Y	P
2-1-25	Kalihiwai R. nr Hanalei	098000		32.0	47.70	14-23			N	C
2-1-26	Puukumu Str. nr Kilauea	097900	A			64-			N	P
2-1-28	Puu Ka Ele Ditch nr Kilauea	095000		3.4		32-67			D	C
2-1-28	Ross Ditch nr Kilauea	095200		3.1		56-67			D	C
2-1-28	Kalihiwai Ditch above wasteway nr Kilauea	095900		4.3		60-68			D	C
2-1-28	Kilauea	096000		2.8		34-67			D	C

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
2-1-28	Pohakuhono Str. nr Kilauea	097000		3.5	8.21	34-67	G	1.80	Y	C
2-1-28	Hanaulani Str. nr Kilauea	097300		2.7		57-72			N	C
2-1-28	Halaulani Str. at alt. 400 ft nr Kilauea	097500	A	7.2	11.50	57-	G	1.90	N	C
2-2-01	Anahola Str. nr Kealia	089000		9.7	22.40	10-85	P	4.27	N	C
2-2-01	Anahola Str. at Anahola	093200		15.0	34.20	62-82	F	9.24	Y	C
2-2-04	Combined records of 16079000, 16080000	080001		13.0		36-85			N	C
2-2-04	Kapaa str. nr Kealia	078000		27.0	36.10	10-20			Y	C
2-2-04	Kapaa str. at Kapahi Ditch intake nr Kapaa	080000	A	5.9	21.50	36-			Y	C-E
2-2-04	Kapaa Str. at old Hwy crossing nr Kealia	084500	A			62-			N	P
2-2-04	Kapahi Ditch nr Kealia	079000	A	4.5	6.16	09-	G		D	C
2-2-04	Kaneha Ditch nr Kealia	081200	A			64-			Y	P
2-2-06	Konohiki Str. nr Kapaa	073500	A			64-			Y	P
2-2-08s	Wailua R. System	000000		110.0	238.56					
2-2-08	Wailua R. nr Kapaa	071800	A			62-				P
2-2-08.01	Left branch Opaekaa nr Kapaa	071500	A	1.8	2.56	60-	G	0.65	N	C
2-2-08.02	N. Fork Wailua R. at alt 650 ft nr Lihue	063000		50.0	73.10	14-85	G	5.29	Y	C
2-2-08.02	E. branch of N. Fork Wailua R. nr LIhue	068000	A	32.0	48.00	12-	G	6.27	N	C
2-2-08.02	N. Fork Wailua R. nr Lihue	068700				10-14			Y	E
2-2-08.02	N. Fork Wailua R. nr Kapaa	071000	A	73.0	122.00	52-	G	17.90	Y	C
2-2-08.03	S. Fork Wailua R. Lihue	060000	A	36.0	114.00	11-	G	22.40	Y	C
2-2-08.03	S. Fork Wailua R. nr rock quarry nr Lihue	058500				74-			Y	L
2-2-15	Huleia Str. nr Lihue	055000	A	10.0	28.00	12-	G	17.60	Y	C-P
2-2-15	Kamooloa Str. nr Puhi	053800		0.6	17.00	63-71	G	5.94	Y	C
2-2-15	Kuia Str. nr Puhi	054500		3.5		63-66			Y	C
2-2-15	Kamooloa Str. nr Puhi	053800		0.6	17.00	63-71	G	5.94	Y	
2-3-04	Lawai Str. nr Koloa	052500	A	3.0		49-			Y	C-P
2-3-04	Hanapepe R. at Hanapepe	052000	A			49-			Y	P
2-3-07	E. Fork Koula R. nr Eleele	041000				11-15			Y	E
2-3-07	Koula R. at Koula nr Eleele	047000		34.0	74.30	10-16			Y	C
2-3-07	Hanapepe R. below Manuahi Str. nr Eleele	049000	A	32.0	84.70	17-	G	18.50	Y	C
2-3-07	Hanapepe Ditch at Hanapepe Falls nr Eleele	042000				11-15			D	E
2-3-07	Hanapepe Ditch below intake nr Eleele	043000			42.50	30-38			D	C
2-3-07	Hanapepe Ditch at Koula nr Eleele	044000			38.50	10-49			D	C
2-4-04s	Waimea R. System	000000		63.0	253.00					
2-4-04	Waiakoali Str. nr Waimea	011000		3.5	8.88	09-80			N	C-L
2-4-04	Kokee Ditch nr Waimea	014000		20.0	24.20	26-82	G		D	C
2-4-04	Kauaikinana Str nr Waimea	012000		2.2	6.24	19-80			N	C-L
2-4-04	Waimea R. at alt 3,420 ft nr Waimea	016000		19.0	44.90	16-68			Y	C
2-4-04	Waialae Str. at alt. 800 ft nr Waimea	019000	A	6.7	21.80	20-	G	1.79	N	C
2-4-04	Waialae Str. nr Waimea	020000		9.9		10-16			N	C
2-4-04	Waialae Str. at alt. 800 ft nr Waimea	021000		16.0		16-21			N	C
2-4-04	Waimea R. below Kekaha Ditch intake nr Waimea	028000		1.4	67.90	21-69			Y	C
2-4-04	Waimea R. near Waimea	031000	A	15.0	124.00	10-	G	57.80	Y	C
2-4-04	Combined records of stations 16031000, 16036000	031001		50.0		43-68			Y	C
2-4-04	Waimea R. at Waimea	038000	A			43-			Y	P
2-4-04	Kekaha Ditch at Camp 1, nr Waimea	022000		55.0	57.10	09-68			D	C
2-4-04	Kekaha Ditch below tunnel 12 nr Waimea	027000		51.0	50.00	08-34			D	C

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
2-4-04.01	Makaweli R. nr Waimea	036000	A	29.0	85.50	43-	G	26.00	Y	C
2-4-04.01	Makaweli R. below Poowaiomahaihai Ditch nr Waimea	037100		23.0	105.00	11-17			Y	C
2-4-04.02	Mokihana Str. nr Waimea	029500				62-80			N	L
2-4-04.04	Koaie Str. at alt. 3,770 ft nr Waimea	017000		8.2	24.60	19-68			N	C
2-4-04.04	Koaie Str. nr Waimea	018000				15-71			N	E
2-4-04.06.1	Mohihi Str. nr Waimea	015000				09-17			N	C
2-4-04.06.1	Mohihi Str. at alt. 3,420 ft nr Waimea	013000		3.0	8.62	20-71	P	1.60	N	C
2-4-04.06.3	Kawaikoi Str. nr Waimea	010000	A	13.0	34.40	09-	G	3.95	N	C
2-5-08	Nahomalu valley nr Mana	130000	A		0.42	62-	F	3.77	N	C-P
	Oahu									
3-1-03	Paumalu Gulch at Sunset Beach	318000	A			67-			N	P
3-1-05	Oio Str. nr Kahuku	311000	A			57-			N	P
3-1-06	Malaekahana Str. nr Laie	308990		0.3	2.14	63-71	F	0.64	N	C
3-1-06	Malaekahana Str. at alt. 30 ft nr Kahuku	310501	A			58-			N	P
3-1-06	Malaekahana Str. nr Kahuku	309000				14-18			N	E
3-1-06	MIddle branch Malaekahana Str. nr Kahuku	310000				14-18			N	C
3-1-07	East branch Kahawainui Str. nr Laie	308000				14-18			N	C
3-1-09	Koloa Gulch nr Laie	306000		2.0		14-18			N	C
3-1-13	Kaluanui Str. nr Punaluu	304200	A	1.3	4.17	67-	G	1.11	N	C
3-1-13	Kaluanui Str. nr Hauula	304500	A			57-			N	P
3-1-16	Punaluu Str. at alt. 250 ft nr Punaluu	301000				14-18			N	E
3-1-16	Combined records of stations 16302000, 16303000	303003		21.0		53-			N	C
3-1-16	Punaluu Ditch nr Punaluu	302000	A	5.8	7.03	53-	P		D	C
3-1-16	Punaluu Str. nr Punaluu	303000	A	12.0	17.70	53-	G	2.78	Y	C
3-1-18	Kahana Str. at mauka trail crossing nr Kahana	295995				60-80			Y	L
3-1-18	Kawa Str. nr Kahana	297000				14-80			N	L
3-1-18	Kahana Str. at alt. 30 ft nr Kahana	296500	A	23.0	36.00	58-	F	3.74	Y	C
3-1-20	Makana Str. at Kaaawa	295900				57-62			N	E
3-2-02	Waikane Str. at alt. 75 ft at Waikane	294900	A	4.1	8.37	59-		2.22	Y	C
3-2-04	Waiahole Str. at alt. 250 ft nr Waiahole	291000		5.2		55-72			Y	C
3-2-04	Waiahole Str. nr Waiahole	292000		42.0		11-16			N	C
3-2-04	Waianu Str. at Waiahole	293100				59-66			N	
3-2-07s	Kahaluu R. System	000000		18.5	16.00					
3-2-07.01	South Fork Waihee Str. nr Heela	283600	A	1.8	1.48	62-	G	0.03	Y	C
3-2-07.01	Waihee Str. at Kahaluu	284500		13.0		59-75			Y	C
3-2-07.01	North Fork Waihee Str. nr Heela	283700	A	1.8	1.62	62-	G	0.03	Y	C
3-2-07.01	Waihee Str. at alt. 260 ft nr Heela	283800		4.3		61-66			Y	C
3-2-07.01	Waihee Str. nr Heela	284000		7.4	7.98	35-82	F	0.93	Y	C
3-2-07.01	Waihee Str. nr Kahaluu	284200	A	4.1	5.81	74-	G	0.97	Y	C
3-2-07.02	Kahaluu Str. tributary nr Kahaluu	283100				48-62			Y	E
3-2-07.02	Kahaluu Str. nr Heela	283000		0.8	0.80	35-71	F	0.28	Y	C
3-2-07.02	Kahaluu Str. nr Kahaluu	283400				62-				L-P
3-2-07.02	Kahaluu Str. at Kahaluu	283500		7.7		59-70			Y	C
3-2-07.02	Kahaluu	283200	A			83-	F	0.99	N	new

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
3-2-07.03	Ahuimanu Str. nr Kahaluu	283480	A			62-			N	L-P
3-2-08	Haiku Str. nr Heeia	275000	A	1.6	2.12	14-	F	0.97	Y	C
3-2-08	Heeia Str. at Kaneohe	279500	A			65-80				P
3-2-08	Iolekaa Str. mauka nr Heeia	278000		0.5	0.64	40-70	F	0.29	Y	C
3-2-09	Keaahala Str. at Kamehameha Hwy at Kaneohe	274499	A			58-			N	P-L
3-2-10	Kamooalii Str. below Kuou Str. nr Kaneohe	270500		7.3		67-76			N	C
3-2-10	Luluku Str. at alt. 220 ft nr Kaneohe	270900	A	1.6		60-	F	0.44	Y	C-P
3-2-10	Kamooalii Str. below Luluku Str. nr Kaneohe	272200	A	6.4	10.50	76-	G	3.81	Y	C
3-2-10	Kamooalii Str. at Kaneohe	273900		11.0	14.00	59-79	F	4.38	Y	C
3-2-10	Kaneohe	273950	A							new
3-2-10	Kaneohe	265600	A			83-	F	1.11		new
3-2-11	Kawa Str. at Kaneohe	265000	A			14-				P
3-2-13	Kawainui canal at Kailua	264800	A			56-				P
3-2-13	Makawao Str. nr Kailua	254000			4.94	12-	G	2.04	Y	
3-2-13	Maunawili Str. nr Kailua	260000				12-16			Y	E
3-2-13	Maunawili Str. at Hwy 61 nr Kailua	260500	A	8.7		22-			Y	C-P
3-2-13	Maunawili Dictch nr Waimanalo	250000		2.8		54-68			D	C
3-2-13	Makawao Str. nr Kailua	254000	A	2.6	4.93	12-	G	2.04	Y	C
3-2-14	Kawainuii swamp drainage canal at Kailua Road at Kailua	264400				62-65				E
3-2-14	Kawainui swamp canal at Wanaao Road at Kailua	264500				62-64				E
3-2-15	Waimanalo Str. at Waimanalo	249000	A	1.7		67-			Y	C-P
3-3-03	Kuliouou valley at Kuliouou	247900	A			57-			N	P
3-3-05	Wailupe Gulch at Aina Haina	247500	A			57-			N	P
3-3-06	Waialaenui Gulch at Honolulu	247200				57-68			N	E
3-3-07.01	East Manoa Dich nr Honolulu	239500		1.0		15-39			D	C
3-3-07.01	Waiakeakua Str. at Honolulu	240500	A	3.6	5.01	13-	F	1.06	Y	C
3-3-07.01	Manoa Str. at College of Hawaii nr Honolulu	242000		7.1		09-18			Y	C
3-3-07.01	Manoa-Palolo drainage canal at Moiliili	247100	A			67-			N	P
3-3-07.01	Waihi Str. at Honolulu	238500		1.7	3.59	13-83	F	1.14	Y	C
3-3-07.01	Pukele Str. nr Honolulu	244000		0.8	1.93	26-82	P	1.18	N	C
3-3-07s	Ala Wai System	000000		5.5	10.60					
3-3-07.01	Manoa	239000			4.78			1.00		C
3-3-07.01	Manoa	240000			3.99			1.14		C
3-3-07.01.1	Waiomao Str. nr Honolulu	246000		0.5	1.86	11-71	F	1.04	Y	C
3-3-07.01.1	Palolo Str. nr Honolulu	247000		1.8	5.64	52-79	P	3.63	Y	C
3-3-09	Moole Ditch makai station nr Honolulu	231700		0.1		18-23			D	C
3-3-09	Waolani Str. at Honolulu	235400	A			57-			Y	P
3-3-09	Nuuanu Str. below reservoir 2 wasteway nr Honolulu	232000	A	3.7	6.90	13-	G	3.35	N	C
3-3-09	Pauoa Str. at Honolulu	237500	A			57-			N	P
3-3-12	Moanalua Str. nr Tripler Hospital	228600	A			70-			N	P
3-3-11	Moanalua Str. nr Tripler Hospital	228900	A	0.4		66-			N	C-P
3-3-11	Kalihi Str. nr Honolulu	229000	A	3.0	6.59	13-	G	2.61	N	C
3-3-11	Kalihi Str. at Kalihi	229300	A	3.9	10.30	62-	F	5.18	N	C
3-3-12	Moanalua Str. nr Kaneohe	227500				68-78				C
3-3-12	Moanalua Str. tributary nr Kaneohe	227700				68-78				C
3-3-12	Moanalua Str. tributary nr Aiea	227900				72-78				E
3-3-12	Moanalua Str. nr Honolulu	228000	A		3.26	26-			N	C-P
3-3-12	Moanalua Str. nr Aiea	228200	A			68-			N	P

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
3-3-12	Moanalua Str. at alt. 100 ft nr Honolulu	228500				57-68			N	E
3-4-02	North Halawa Str. nr Aiea	226000	A	0.3	4.82	29-	G	3.45	N	C
3-4-02	Halawa Str. at Aiea	227000		3.8		53-80			Y	C-P
3-4-02	Halawa	226200	A			83-	F	4.01		C
3-4-04	Pearl Harbor springs at Kalauao	224000	A	25.0	24.40	31-				C-L
3-4-04	Kalauao Str. at Aiea	225000		1.9		53-57			Y	C
3-4-04	Kalauao Str. at Moanalua Road at Aiea	224500	A	0.2		57-82			Y	P
3-4-05	Waimalu Str. nr Aiea	223000	A	1.3		52-				C-P
3-4-06	Pearl Harbor springs at Waiawa	214000	A	19.0	18.40	31-80				C-L
3-4-06	Waiawa Str. nr Pearl City	216000	A	7.3	32.60	52-	G	26.40	Y	C
3-4-10	Waikele Str. at Wheeler Field	212601	A			59-				P
3-4-10	Waikele Str. at Waipahu	213000	A	25.0	37.60	51-	G	45.70	Y	C
3-4-10	Waikakalaua Str. nr Wahiawa	212700	A			57-			Y	P
3-4-10	Huliwai Gulch nr Kunia Camp	212750	A			73-			N	P
3-4-10	Kipapa Str. nr Wahiawa	212800	A	2.6	10.60	57-	G	4.29	N	C
3-4-10	Kipapa Str. nr Waipahu	212900				66-68			Y	C
3-4-11	Honouliuli Str. nr Waipahu	212500	A			55-			Y	P
3-5-01	Nanakuli Str. nr Nanakuli	212300	A			67-			N	P
3-5-04	Mailiili Str. nr Waianae	212200	A			57-			N	P
3-5-05	Kaupuni Str. at alt. 374 ft nr Waianae	211800	A	0.3		60-80			Y	C-P
3-5-05	Puea Mauka Ditch nr Waianae	211850		0.5		60-67			D	C
3-5-07	Makaha Str. nr Makaha	211600	A	0.5	1.88	59-	G	2.31	N	C
3-5-07	Makaha Str. at Makaha	211700	A			66-			Y	P
3-5-08	Makua Str. nr Makua	211500	A			57-			N	P
3-6-04	Makaleha Str. nr Waialua	211300	A			57-			N	C-P
3-6-06s	Kiikii System	000000		14.9	32.00					
3-6-06	Kaukonahua Str. at Waialua	210500	A			67-			Y	P
3-6-06.01	Poamoho tunnel nr Wahiawa	210900		1.0	4.85	58-79	G		D	C
3-6-06.01	Poamoho Str.nr Wahiawa	211000		1.5	4.07	47-74	G	1.79	Y	C
3-6-06.01	Combined records of stations 16210900, 16211000	211003				58-74			N	C
3-6-06.01	Poamoho Str. at Waialua	211200	A			67-			Y	P
3-6-06.02.1	North Fork Kaukonahua Str. above right branch nr Wahiawa	200000	A	7.7	16.30	13-	G	1.38	N	C
3-6-06.02.1	Right branch of North fork Kaukonahua Str. nr Wahiawa	201000		4.9	11.30	13-80			N	C-L
3-6-06.02.1	Mauka Ditch nr Wahiawa	203000		3.8		47-68			D	C
3-6-06.02.1	North Fork Kaukonahua Str. nr Wahiawa	204000		13.0		46-68			Y	C
3-6-06.02.2	South Fork Kaukonahua Str. nr Wahiawa	206000		5.7	11.70	13-57			N	C
3-6-06.02.2	South Fork Kaukonahua str. at east pump reservoir nr Wahiawa	208000	A	8.8	21.20	57-	G	4.04	N	C
3-6-06.02.2	Right branch of South Fork Kaukonahua Str. nr Wahiawa	208500		0.7	2.03	57-72	F	0.86	Y	C
3-6-06.02.2	South Fork Kaukonahua Str. above Wahiawa reservoir nr Wahiawa	209000		13.0		46-58			Y	C
3-6-07s	Paukauila System	000000		4.5	24.30					
3-6-07.01	Opaeula Str. nr Wahiawa	345000	A	4.3	13.50	59-	G	2.98	N	C
3-6-07.01	Opaeula Str. nr Haleiwa	350000	A			55-			Y	P
3-6-07.02	Helemano Str. at Haleiwa	343000		0.2	10.80	67-82	P	14.20	Y	C
3-6-08	Anahulu R. nr Haleiwa	340000	A			57-			Y	P
3-6-08	Anahulu R. tributary nr Haleiwa	340500				67-71			Y	E
3-6-10	Waimea Gulch nr Kawailoa Camp	331000	A			67-			N	P
3-6-10	Kamananui Str. at Pupukea military Road nr Maunawai	325000	A	3.3	10.10	60-	F	3.13	N	C
3-6-10	Kaiwikoele Str. tributary nr Maunawai	329000				67-71			N	C

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
3-6-10	Kamananui Str. at Maunawai	330000	A	3.7	16.90	58-	G	12.36	N	C
3-6-10	Kamananui Str. at Pupukea military Road nr Maunawai	325000				60-				
	Molokai									
4-1-03	Waikolu Str. at alt. 900 ft nr Kalaupapa	405500	A	2.8	6.79	56-	F	1.99	Y	C
4-1-03	Waikolu Str. at elevation 650 ft nr Kalaupapa	406000		8.9		20-23			N	C
4-1-03	Waikolu Str. below pipeline crossing nr Kalaupapa	408000	A	12.0	15.70	19-	F	3.68	Y	C
4-1-09	Kapuhi Str. at alt. 1,000 ft nr Pelekunu	403400	A			68-			N	L
4-1-09	Lanipuni Str. nr Pelekunu	405000		8.3	40.70	19-57			N	C
4-1-09	Kawailena Str. nr Pelekunu	403500	A			68-			N	L
4-1-09	Kapuhi Str. nr Pelekunu	403600	A	3.8		68-			N	C-L
4-1-09	Kawainui Str. at alt. 1,000 ft nr Pelekunu	403700	A			68-			N	L
4-1-09	Kawaipoka Str. nr Pelekunu	403800	A			68-			N	L
4-1-09	Kawainui Str. nr Pelekunu	403900	A	4.9		68-80			N	C
4-1-09	Pelekuniu Str. nr Pelekunu	404000		9.3	16.40	19-81	F	2.59	N	C
4-1-09	Pilipililau Str. nr Pelekunu	404200	A	0.9	1.54	68-	F	0.49	N	C
4-1-15	Pulena Str. nr Wailau	402000		20.0	34.20	19-57			N	C
4-1-15	Waiakeakua Str. nr Wailau	403000		7.6	11.60	19-57			N	C
4-1-19	Papalaua Str. nr Pukoo	401000		10.0	21.20	19-29			N	C
4-1-21	Halawa Str.nr Halawa	400000	A	14.0	29.20	17-	F	4.62	N	C
4-2-01	Pohakupili Gulch nr Halawa	419000	A			63-			N	P
4-2-08	Punaula Gulch nr Pukoo	416000		0.4	1.26	47-72	G	0.24	N	C
4-2-14	Wawaia Gulch at Kamalo	415400	A			63-			N	P
4-2-15	East Fork Kawela Gulch nr Kamalo	415000		0.4	2.38	46-71	G	0.45	Y	C
4-2-16	Papio Gulch at Halawa	419500	A	0.1	0.78	63-	F	0.94	Y	C
	Maui									
6-1-01	Ukumehame Gulch nr Olowalu	647000		8.1	12.70	11-19			N	C
6-1-01	Ukumehame Gulch at mouth nr Olowalu	647100				64-71				E
6-1-02	Olowalu Ditch nr Olowalu	645000		6.6		11-67			D	C
6-1-02	Olowalu Str. nr Olowalu	646000			7.44	11-16				E
6-1-02	Olowalu Str. at Olowalu	646200	A			63-			Y	C-P
6-1-03	Launiupoku Str. nr Lahaina	644000		1.6		11-18			Y	C
6-1-04	Kauaula Str. nr Lahaina	641000				14-17			N	C
6-1-04	Kauaula Str. nr mouth nr Lahaina	643300	A			63-			Y	P
6-1-04	Kauaula Ditch nr Lahaina	643000		9.5	10.40	11-17			D	C
6-1-05	Kahoma development tunnel nr Lahaina	633000		4.4	4.58	11-17			D	C
6-1-05	Kahoma Str. at Lahaina	638500	A		3.27	62-	P	5.22	Y	C
6-1-05	Kahoma Str. nr Lahaina	634000		6.2		11-17			Y	C
6-1-05	Kanaha Str. above pipeline intake nr Lahaina	636000		5.0	7.81	16-32			N	C
6-1-05	Kanaha Str. nr Lahaina	638000		1.6		11-16			Y	C
6-1-07	Honokowai Str. nr Lahaina	630000		1.3		13-17			Y	C
6-1-07	Honokowai Str. at Honokowai	630200	A			61-			Y	P
6-1-07	Honokowai Ditch nr Lahaina	629000		6.9	9.05	12-67			D	C
6-1-10	Honolua Str. nr Honokohau	623000		5.0		13-17				C
6-1-11	Honokohau Str. nr Honokohau	620000	A	24.0	39.40	11-	G	4.11	N	C

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
6-1-11	Honokohau Ditch intake nr Honokohau	621000		36.6	34.10	07-13			D	C
6-2-01	Poelua Gulch nr Kahakuloa	619700	A			64-				P
6-2-03	Kahakuloa Str. nr Honokohau	618000	A	8.9	17.30	39-	F	3.47	N	C
6-2-06	Left branch Makamakaole Str. nr Waihee	617000		1.7	2.88	39-52			Y	C
6-2-07	Waihee R. nr Waihee	612000				13-17				C
6-2-07	Waihee R. at dam nr Waihee	614000	A	59	84	83-	F	4.20	Y	new
6-2-08	North Waiehu Ditch nr Wailuku	609000				10-17			D	E
6-2-08	South Waiehu Str. nr Wailuku	610000				10-17			Y	C
6-2-09	Iao Str.nr Wailuku	604000				10-15			N	E
6-2-09	Iao	604500	A	43	65	83-	F	5.98	Y	new
6-2-09	Iao Str. at Wailuku	607000	A			50-			Y	P
6-2-10	Waikapu Str. nr Waikapu	650000			6.71	10-17			Y	E
6-2-10	Waikapu Str. nr Kihei	650500	A			63-			Y	P
6-2-10	South side Waikapu Ditch nr Waikapu	648000		6.8	7.55	10-17			D	C
6-2-10	Palolo Ditch nr Waikapu	649000		3.4	3.42	10-17			D	C
6-3-01	Unnamed Gulch at Maliko Bay	603300	A			62-			N	P
6-3-03	Awalau Gulch at Kailiili	602400		2.7	3.56	65-71	G	0.23		C
6-3-07	Halehaku Gulch nr Kailiili	596200		0.5	1.00	65-71	G	0.13	N	C
6-3-07	Opana Tunnel nr Kakipi	599500	A	2.0	3.12	65-	G		D	C
6-3-07	Kauhikoa Ditch at Opana weir nr Huelo	602000		10.0	22.70	10-28			D	C
6-3-07	Opana Str. nr Huelo	601000				10-16			N	E
6-3-08	Honopou Str. nr Huelo	587000	A	2.5	4.69	10-	G	0.64	N	C
6-3-08	Honopou Str. below Haiku Ditch nr Huelo	595000		1.2	7.94	32-47			Y	C
6-3-08	Honopou Str. at Lowrie Ditch siphon nr Huelo	591000		0.2	2.09	32-47			Y	C
6-3-08	Honopou Str. aboe Haiku Ditch nr Huele	593000		0.7	2.43	32-47			Y	C
6-3-09	Hoolawanui Str.nr Huelo	585000		5.6	11.90	10-71	G	1.34	N	C
6-3-09	Hoolawaliilii Str. nr Huelo	586000			7.83	11-57		0.55	N	C
6-3-14	Kailua Str. at Haiku-uka boundary nr Kailiili	574000		0.5	6.13	18-34			N	C
6-3-14	Kailua Str. nr Huelo	577000		9.8	29.60	10-58			N	C
6-3-14	Kailua nr Kailiili	574500		1.1	6.83	63-71	G	1.10	N	C
6-3-14	East branch Kailua Str. nr Kailiili	576200				63-68			N	E
6-3-14	Oanui Str. nr Huelo	580000				10-16			N	E
6-3-15	Nailiilihaele Str. nr Kailiili	569100				63-68			N	E
6-3-15	Nailiilihaele Str. nr Huelo	570000		17.0	35.50	10-75	G	3.49	Y	C
6-4-01	Oopuola Str. nr Huelo	566000		1.2	2.74	30-57			N	C
6-4-01	Oopuola Str. above spreckels Ditch crossing nr Huelo	567000		2.5	38.40	10-15			Y	C
6-4-01	Kaalea Gulch nr Huelo	565000		2.9	7.23	21-62			N	C
6-4-04	Waikamoi Str. nr Huelo	556000		9.3	28.20	10-22			Y	C
6-4-04	Waikamoi Str. at Puu Luau nr Olinda	552600				49-66			N	C
6-4-04	Waikamoi Str. obove reservoir at Kula Pipeline intake near Olinda	552800		0.1		53-68			N	C
6-4-04	Waikamoi Str. below reservoir at Kula Pipeline intake nr Olinda	553000							Y	E
6-4-04	Waikamoi Str. at Haiku-uka boundary nr Kailiili	554000		2.3	12.60	18-34			Y	C
6-4-04	East branch Waikamoi Str. at Haiku-uka boundary nr Kailiili	554500		1.5	4.24	18-33			Y	C
6-4-04	Waikamoi Str. above Wailoa Ditch nr Huelo	555000		8.0	25.50	22-57			Y	C
6-4-04	Alo Str. nr Huelo	557000		3.1	7.58	10-57			N	C

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
6-4-06	East branch Puohokamoa Str. at Haiku-uka boundary nr Kailiili	542000		0.9	1.83	19-68			N	C
6-4-06	Middle branch Puohokamoa Str. at Haiku-uka boundary nr Kailiili	543000		1.4	4.24	19-69			Y	C
6-4-06	West branch Puohokamoa Str. at Haiku-uka boundary nr Kailiili	544000		1.7	5.49	19-34			Y	C
6-4-06	Puohokamoa Str. above Apreckels Ditch nr Huelo	545000		14.0	33.10	13-71	G	2.35	Y	C
6-4-06	Puohokamoa intake of Koolau Ditch nr Huelo	547000			26.10	22-30			D	E
6-4-07	Kula diversion from Haipuaena Str. nr Olinda	531000		0.4	0.69	45-85	G		D	C
6-4-07	Haipuaena Str. at Kula pipeline intake nr Olinda	531100				46-68			Y	C
6-4-07	Haipuaena Str. at Haiku-uka boundary nr Kailiili	532000		1.8	5.15	19-68			Y	C
6-4-07	Haipuaena Str. above Spreckels Ditch nr Huelo	536000		5.4	16.20	13-67			Y	C
6-4-07	Haipuaena diversion Ditch at Kolea Gulch nr Keanae	535000		2.7	3.05	38-60			D	C
6-4-07	Spreckels Ditch at Haipuaena weir nr Huelo	538000		16.0	29.30	22-85	E		D	C
6-4-09	Honomanu Str. at Haiku-uka boundary nr Kaili	524000		2.1	14.70	19-68			D	C
6-4-09	Honomanu Str. nr Keanae	527000		6.2	24.90	13-64			N	C
6-4-11	Taro patch feeder ditch at Keanae	522000		3.5	3.54	34-68			D	C
6-4-14	West Wailuanui Str. nr Keanae	519000		5.2	15.20	13-58			N	C
6-4-14	East Wailuanui Str. nr Keanae	520000		3.8	9.04	14-58			N	C
6-4-14	Wailuanui Str. nr Keanae	521000		1.4	14.10	32-47			Y	C
6-4-15	West Wailuaiki Str. nr Keanae	518000	A	11.0	35.20	14-	G	3.66	N	C
6-4-16	East Wailuaiki Str. nr Keanae	517000			31.40	13-58			N	C
6-4-17	Kopiliula Str. nr Keanae	516000		9.1	29.20	14-58			N	C
6-4-18	Waiohue Gulch nr Nahiku	515000		6.7	12.10	21-63			N	C
6-4-19	Paakea Gulch nr Nahiku	514000		4.2	6.50	32-47			Y	C
6-4-20	Waiaaka Str. nr Nahiku	513000		0.9	1.25	32-47			Y	C
6-4-21	Kapaula Gulch nr Nahiku	510000		5.3	16.70	21-63			N	C
6-4-21	Kapaula Gulch below government Road nr Nahiku	511000		2.8	12.40	32-47			Y	C
6-4-22	Hanawi Str. nr Nahiku	508000	A	7.2	23.20	14-	G	3.49	N	C
6-4-22	Hanawi Str. below government Road nr Nahiku	509000		21.0	41.90	32-47			Y	C
6-4-23	Makapipi Str. nr Nahiku	507000		3.1	9.67	32-45			Y	C
6-4-34	Kawaipapa Gulch at Hana	502900	A			65-			N	P
6-4-34	Kaeleku flume nr Kaeleku	503000				40-45			D	C
6-4-34	Hana flume nr Hana	504000				40-45			D	C
6-5-01	Moomoonui Gulch at Hana	502800	A			63-			N	P
6-5-11	Hahalawe Gulch nr Kipahulu	502000		3.2	5.46	27-77			N	C
6-5-13	Palikea Str. below diversion dam nr Kipahulu	501000		5.4	57.30	27-83	G	6.29	N	C
6-5-13	Oheo	501200	A							new
6-5-17	Kukuiula Gulch nr Kipahulu	500800	A	1.5		63-			N	C-P
	Hawaii									
8-1-07	Hapahapai Gulch at Kapaau	752600	A			62-			N	P
8-1-16	East branch Honokane nui Str. nr Niulii	747500		21.0		63-69			Y	C
8-1-17	East Honokane iki intake to Awini Ditch nr Niulii	744000		0.9	1.76	27-72				C
8-1-29	Kukui Str. nr Waimanu	742000		0.9		39-66			N	C

CODE	NAME	GAGE #	ACT-IVE	MED-IAN	AVE-RAGE	YRS REC	QUAL DATA	DRA-IN	DIV	TYPE DATA
8-1-30	Paopao Str. nr Waimanu	741000		1.1	3.33	39-52			N	C
8-1-31	Waiaalala Str. nr Waimanu	740000		0.6	1.10	39-52			N	C
8-1-32	Punalulu Str.nr Waimanu	739000		2.4	6.53	39-52			N	C
8-1-33	Kaimu Str. nr Waimanu	738000		3.2	8.68	39-52			N	C
8-1-35	Waiilikahi Str. nr Waimanu	737000		4.3	10.00	39-60			N	C
8-1-44	Kawainui Str. nr Kamuela	720000	A	4.3	14.80	64-	G	1.58	N	C
8-1-44	Alakahi Str. nr Kamuela	725000	A	3.1	6.88	64-	G	0.87	Y	C
8-1-44	Wailoa Str.nr Waipio	732200		51.0	75	01-69			Y	C
8-1-44	Kawaiki Str. nr Kamuela	720300	A	1.7	4.27	68-	G	0.45	N	C
8-1-55	Honokaia Gulch tributary nr Honokaa	717950	A			62-			N	P
8-1-60	Ahualoa Gulch at Honokaa	717920	A			62-			N	P
8-1-87	Keehia Gulch nr Ookala	717850	A			62-			N	P
8-2-06	Manowaiopae Str. nr Laupahoehoe	717820		3.4	8.42	65-71	G	1.04	Y	C
8-2-16	Pohakupuka Str. nr Papaaloa	717800	A	7.7	27.10	62-	G	2.76	N	C-P
8-2-37	Kapehu Str. nr Pepeekeo	717650	A			62-			N	P
8-2-37	Kapehu Str. at Piihonua nr Hilo	709000			50.90	28-37		4.84	N	
8-2-39	Alia Str. nr Hilo	717600	A	12.0		62-			N	C-P
8-2-47	Kalaoa Mauka Str. nr Hilo	717400	A			62-			N	new
8-2-56	Honolii Str. nr Hilo	716000		13.0	52.00	24-32			N	C
8-2-56	Honolii Str. nr Papaikou	717000	A	38.0	125.00	11-	F	11.60	N	C
8-2-60	Wailuku R. nr Pua Akala	701700				64-65			N	C
8-2-60	Wailuku R. at Hilo	713000	A	160.0	386.00	77-	G	256.00	Y	C
8-2-60	Wailuku R. nr Humuula	701750			2.82	65-	G	34.80	N	C
8-2-60	Wailuku R. nr Kaumana	701800		2.9	27.60	66-	G	43.40	N	C
8-2-60	Wailuku R. at Pukamaui nr Hilo	703000		26.7	93.30	23-40			Y	C
8-2-60	Wailuku R. at Piihonua	704000	A	83.8	279.00	28-	F	230.00	Y	C
8-2-61	Waiakea Str. nr Mountain View	700000	A	8.9	11.60	30-	G	17.40	N	C
8-2-61	Wailoa R. at Hilo	701300	A			67-			Y	P
8-2-61	Wailoa R. nr Hilo	701200				57-67			Y	C
8-3-01	Hilea Gulch tributary nr Honuapo	764000	A	1.2	7.47	66-	F	9.17	N	C
8-3-01	Hilea Gulch tributary no. 2 nr Honuapo	765000			3.00	66-	G	1.86	N	C
8-4-01	Kiilae Str. nr Honaunau	759800			0.21	58-	G	0.67	N	C
8-4-02	Right branch Waiaha Str. nr Holualoa	759200			0.31	60-	G	1.89	N	C
8-4-02	Waiaha Str. nr Holualoa	759500				57-68			Y	C
8-4-02	Waiaha Str. at Luawai nr Holualoa	759300	A			60-			Y	C-P
8-5-03	Waikoloa Str. nr Kamuela	757000		4.0	7.21	47-71	G	0.78	N	C
8-5-03	Waikoloa at marine dam nr Kamuela	758000	A	4.2	9.00	47-	G	1.18	Y	C
8-5-03	Kohakohau Str. nr Kamuela	756000	A	1.9	8.49	56-	G	2.51	Y	C
8-5-03	Hauani Gulch nr Kamuela	759000	A		1.61	56-	G	0.47	Y	C

Note: Gaging records for stream and ditch gages are directly associated with a particular stream.
See Table 12 Ditch Gages for a complete list of those associated with Ditches.

Table 9 Stream Size

(Limited to streams with gaging records)

CODE	HSA code; island-hydrographic unit-stream(system)
STREAM	Stream name at mouth
# GAGE	Number of gages on a stream
AVER AGE	Average of yearly mean flow (cfs)
MEDIAN	Flow equalled or exceeded 50% of time

Stream sizes based on average or median discharge.

Large streams	Median flows greater than or equal to 50 cfs or average flows equal or greater than to 80 cfs.
Medium streams	Median flows between 10 and 15 cfs or average flows between 20 and 80 cfs.
Small streams	Median flows less than or equal to 10 cfs or average flows less than or equal to 20 cfs.

Note: When a stream has more than one gaging station, the largest average and median flows were used. In some cases, tributary flows were combined to arrive at main stem estimates. See Table 8.

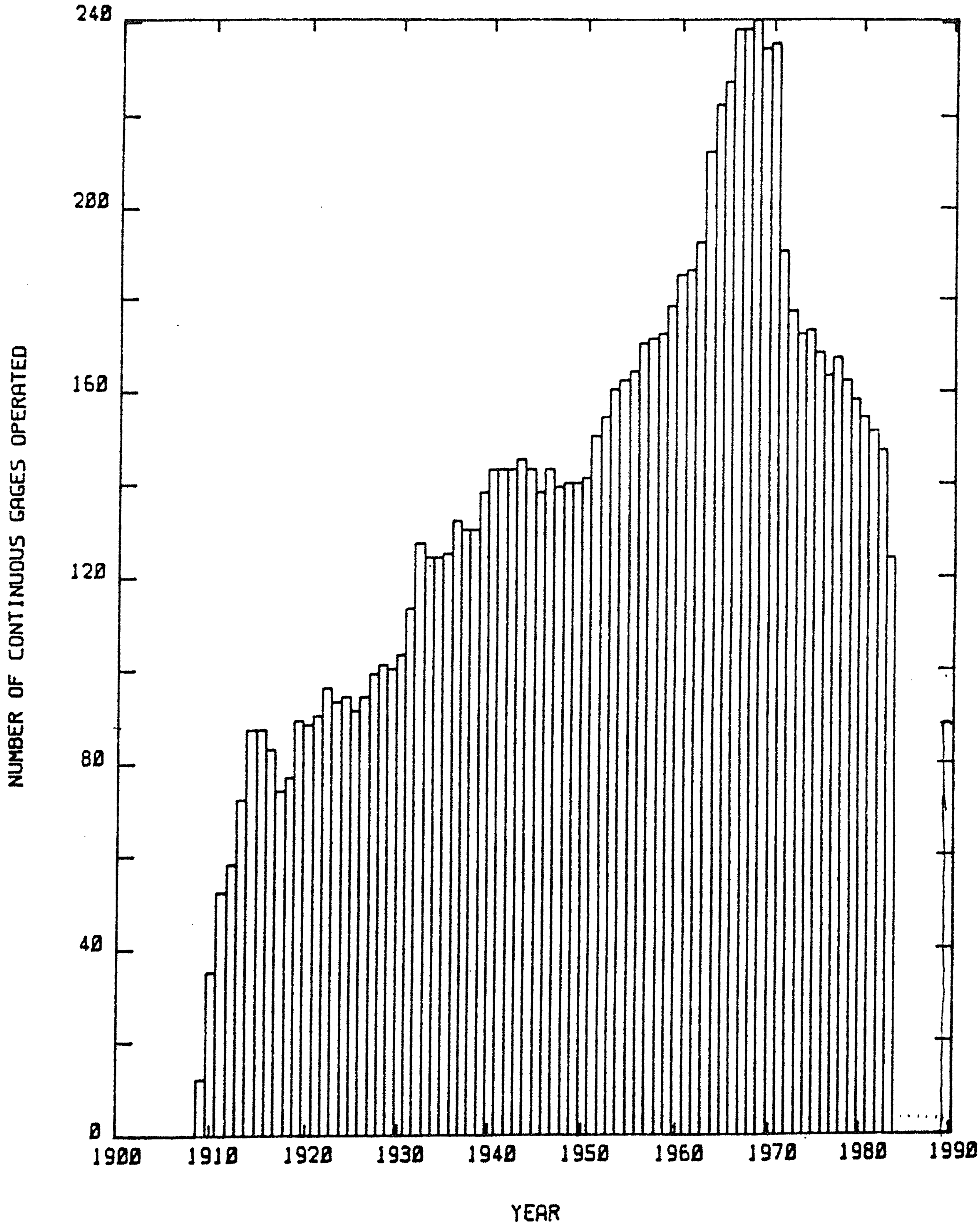
CODE	STREAM	# GAGE	AVER AGE	MED-IAN
Large				
2-1-14	Wainiha R.	3	138.00	79.0
2-1-15	Lumahai R.	1	117.00	67.0
2-1-19	Hanalei R.	8	212.00	130.0
2-2-08s	Wailua S.	8	238.56	110.0
2-3-07	Hanapepe	6	84.70	32.0
2-4-04s	Waimea S.	21	253.00	63.0
6-2-07	Waihee	1	82	?
6-2-09	Iao	1	65	43.0
8-1-44	Wailoa/Waipio	4	75	51.0
8-2-56	Honolii	2	125.00	38.0
8-2-60	Wailuku R.	6	84	59.0
Medium				
2-1-18	Waioli	1	31.60	20.0
2-1-25	Kalihiwai R.	1	47.70	32.0
2-2-01	Anahola	2	34.20	15.0
2-2-04	Kapaa	6	21.50	5.9
2-2-15	Huleia	4	28.00	10.0
3-1-16	Punaluu	4	17.70	12.0
3-1-18	Kahana	3	36.00	23.0
3-2-04	Waiahole	2		42.0
3-2-07s	Kahaluu S.	12	16.00	18.5
3-2-10	Kaneohe	6	14.00	11.0
3-4-04	Kalauao	3	24.40	25.0
3-4-06	Waiawa	2	32.60	7.3
3-4-10	Waikele	6	37.60	25.0
3-6-06s	Kiikii S.	13	32.00	14.9
3-6-07s	Paukauila	3	24.30	4.5
4-1-03	Waikolu	3	15.70	12.0
4-1-09	Pelekunu	9	40.70	8.3
4-1-15	Wailau	2	34.20	20.0
4-1-19	Kawainui	1	21.20	10.0
4-1-21	Halawa	1	29.20	14.0
6-1-11	Honokohau	2	39.40	24.0
6-3-14	Kailua	5	29.60	9.8
6-3-15	Nailiilihaele	2	35.50	17.0
6-4-01	Oopuola	3	38.40	2.5
6-4-04	Waikamoi	8	28.20	9.3
6-4-06	Puohokamoa	5	33.10	14.0
6-4-09	Honomanu	2	24.90	6.2
6-4-15	W. Wailuaiki	1	35.20	11.0
6-4-16	E. Wailuaiki	1	31.40	
6-4-17	Kopiliula	1	29.20	9.1
6-4-22	Hanawi	2	41.90	21.0
6-5-13	Oheo Gl	2	57.30	5.4
8-1-16	Honokane Nui	1		21.0
8-2-16	Pohakupuka	1	27.10	7.7
8-2-37	Kapehu	2	50.90	
8-2-39	Alia	1		12.0

CODE	STREAM	# GAGE	AVERAGE	MEDIAN
Small				
2-1-04	Kalalau	1	6.89	5.2
2-1-07	Hanakoa	1	5.51	1.8
2-1-10	Hanakapiai	1	16.90	8.4
2-1-28	Kilauea	7	8.21	3.5
2-3-04	Lawai	2		3.0
2-5-08	Nahomalu	1	0.42	0.3
3-1-06	Malaekahana	4	2.14	2.0
3-1-09	Koloa Gl.	1		1.3
3-1-13	Kaluanui	2	4.17	4.1
3-2-02	Waikane	1	8.37	
3-2-08	Heeia	3	2.12	1.6
3-2-13	Kawainui/ Maunawili	6		8.7
3-2-15	Waimanalo	1		1.7
3-3-07s	Ala Wai S.	10	10.60	5.5
3-3-09	Nuuanu	4	6.90	3.7
3-3-11	Kalihi	3	10.30	3.9
3-3-12	Moanalua	7	3.26	
3-4-02	Halawa	3		3.8
3-4-05	Waimalu	1		1.3
3-5-05	Kaupuni	2		0.5
3-5-07	Makaha	2	1.88	0.5
3-6-10	Waimea R.	5	16.90	3.7
4-2-08	Mapulehu	1	1.26	0.4
4-2-14	Kamalo	1	0.00	
4-2-15	Kawela	1	2.38	0.4
4-2-16	Papio	1	0.78	0.1
6-1-01	Ukumehame	2	12.70	8.1
6-1-02	Olowalu	3		6.6
6-1-03	Launiupoku	1		1.6
6-1-05	Kahoma	5	3.27	

CODE	STREAM	# GAGE	AVERAGE	MEDIAN
6-1-07	Honokowai	3		1.3
6-1-10	Honolua	1		5.0
6-2-03	Kahakuloa	1	17.30	8.9
6-2-06	Makamakaole	1	2.88	1.7
6-2-10	Waikapu	4	6.71	
6-3-03	Kaupakulua	1	3.56	2.7
6-3-07	Kakipi	4	1.00	0.5
6-3-08	Honopou	4	7.94	1.2
6-3-09	Hoolawa	2	11.90	5.6
6-4-07	Haipuaena	6	16.20	5.4
6-4-11	Piinaau	1	3.54	3.5
6-4-14	Wailuanui	3	15.20	5.2
6-4-18	Waiohue Gl.	1	12.10	6.7
6-4-19	Paakea	1	6.5	4.2
6-4-20	Waiaaka	1	1.25	0.9
6-4-21	Kapaula	2	16.70	5.3
6-4-23	Makapipi	1	9.67	3.1
6-5-11	Hahalawe	1	5.46	3.2
6-5-17	Kukuiula	1		1.5
8-1-17	Honokane Iki	1	1.76	0.9
8-1-29	Kukui	1		0.9
8-1-30	Paopao	1	3.33	1.1
8-1-31	Waiaalala	1	1.10	0.6
8-1-32	Punalulu	1	6.53	2.4
8-1-33	Kaimu	1	8.68	3.2
8-1-35	Waimanu	1	10.00	4.3
8-2-06	Manowaiopae	1	8.42	3.4
8-2-47	Kalaoa	1		
8-2-61	Wailoa R.	3	11.60	8.9
8-3-01	Hilea	2	7.47	1.2
8-4-01	Kiilae	1	0.21	
8-4-02	Waiaha	3	0.31	
8-5-03	Waikoloa	3	9.00	4.2

Discharge figures should be used with extreme caution. The USGS monitoring program in Hawaii was and is not designed to determine general stream characteristics or to calculate instream flow. Therefore using data from stations located above a diversion or on a tributary, or old records or records prior to diversion, will likely give an inaccurate picture of instream flow. Using this sometimes inappropriate or inadequate data to estimate instream flow or arrive at relative stream size has obvious drawbacks. On the other hand, it is the only standardized measurement available, and until more appropriate data is collected, can serve as a starting point for stream size comparison.

Figure 1 History of Continuous Gaging



Source: Cost Effectiveness of the Stream Gaging Program in the Hawaii District, USGS, 1985.

Map 2 Gaging Stations (1988)

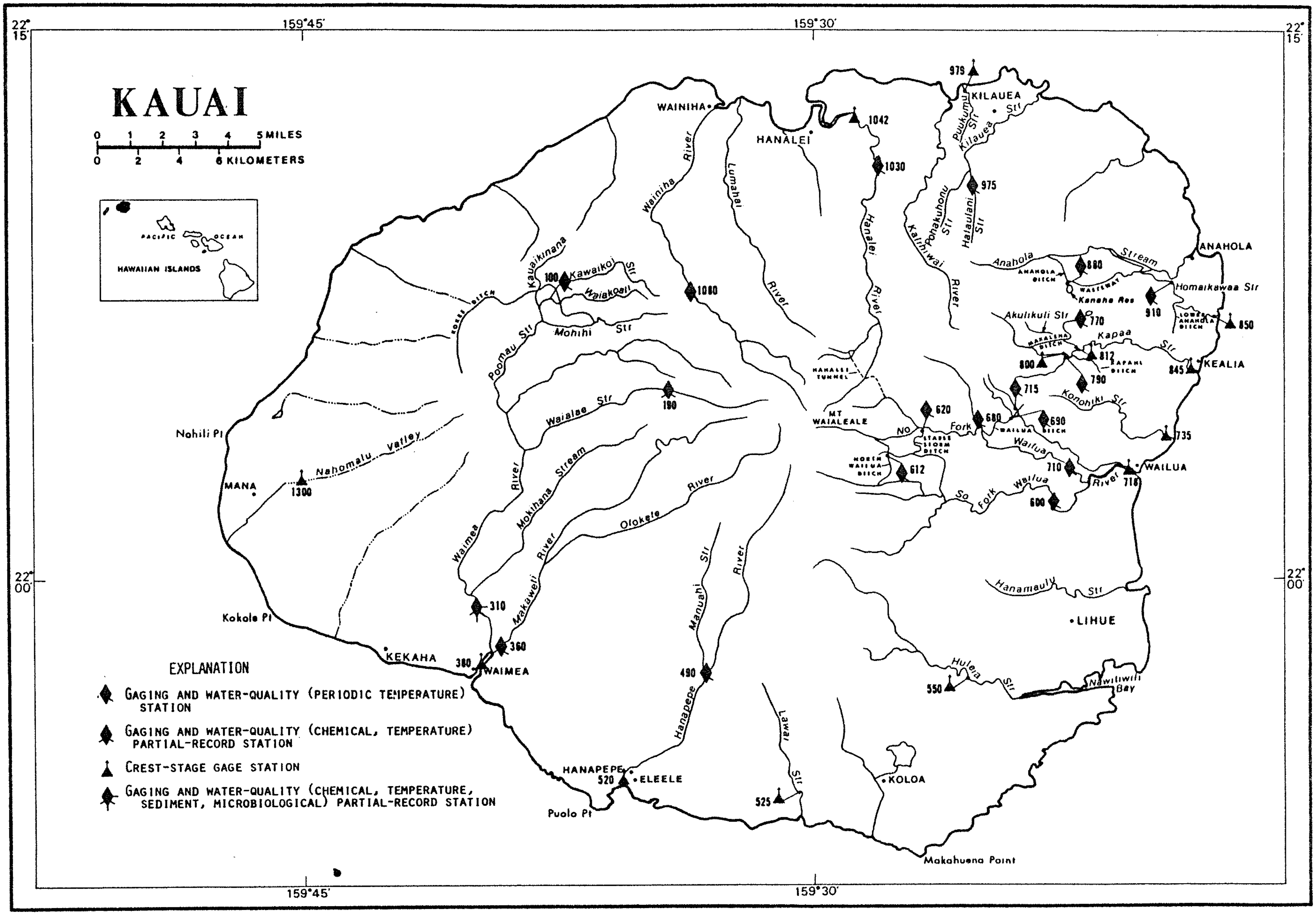


FIGURE 2.--LOCATIONS OF GAGING, WATER-QUALITY, AND PARTIAL-RECORD STATIONS ON KAUAI.

Source: USGS Water Data Report HI-88-1

Map 2 Gaging Stations (1988)

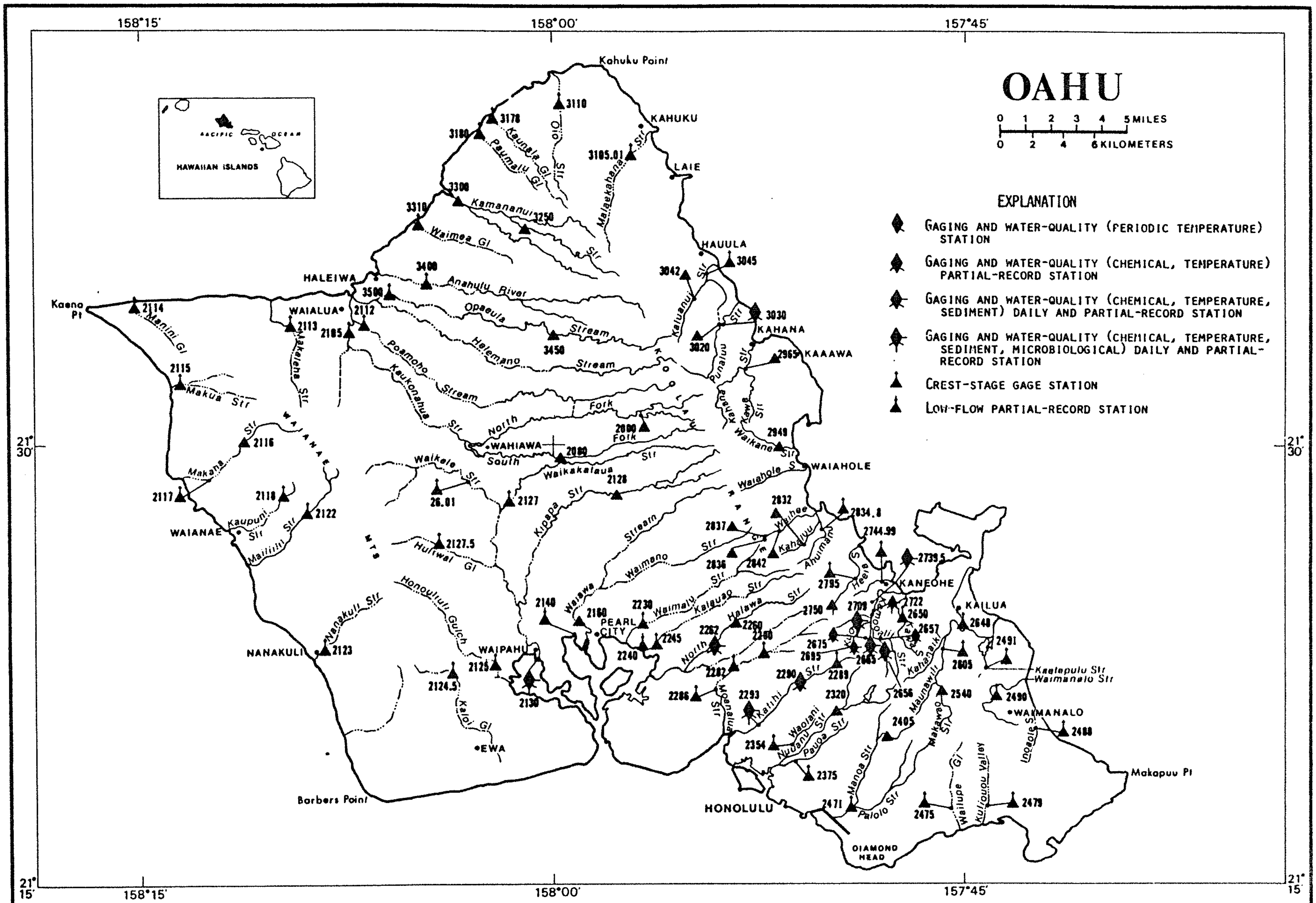


FIGURE 4.--LOCATIONS OF GAGING, WATER-QUALITY, AND PARTIAL-RECORD STATIONS ON OAHU.

Source: USGS Water Data Report HI-88-1

Map 2 Gaging Stations (1988)

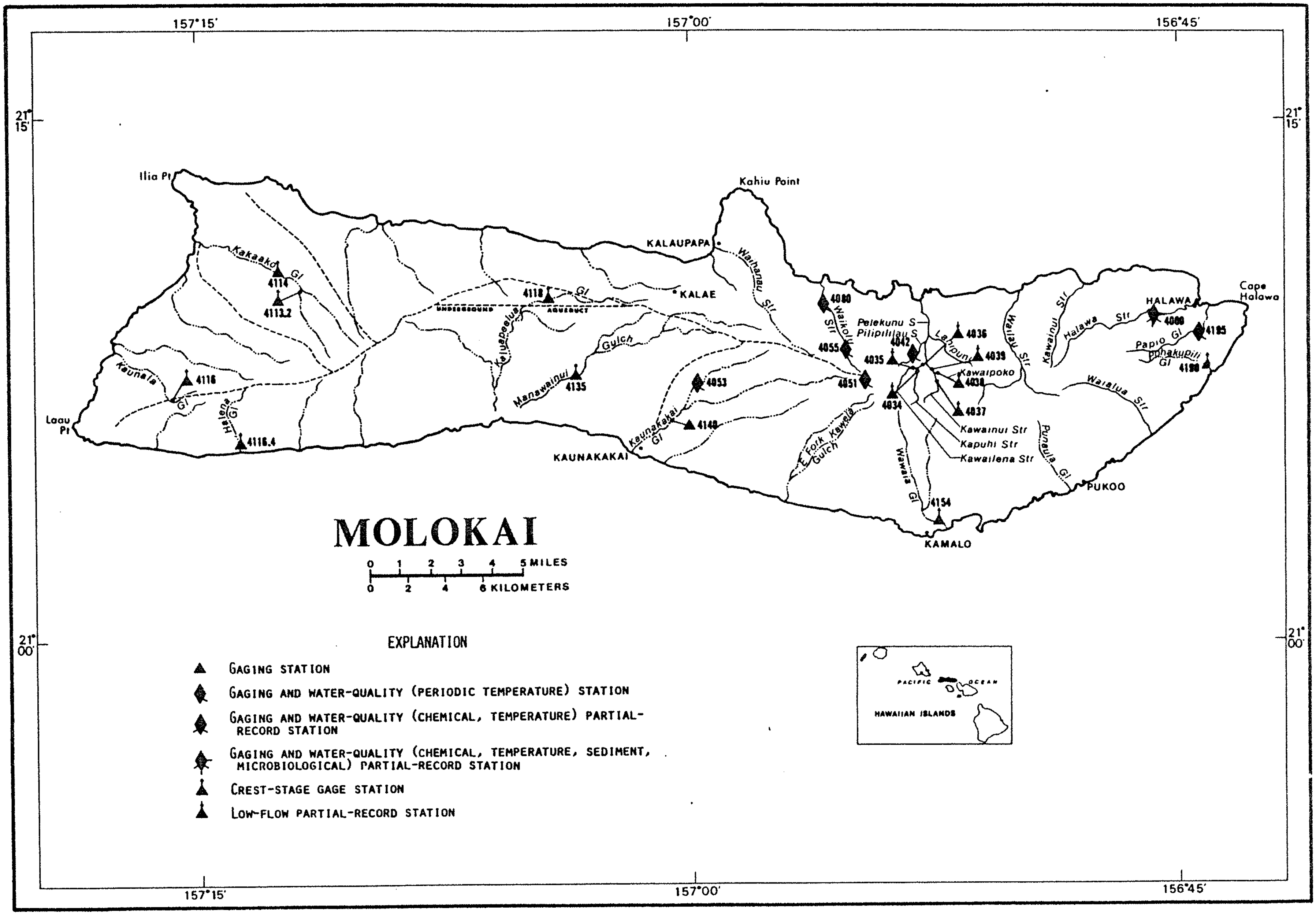


FIGURE 6.--LOCATIONS OF GAGING, WATER-QUALITY, AND PARTIAL-RECORD STATIONS ON MOLOKAI.

Source: USGS Water Data Report HI-88-1

Map 2 Gaging Stations (1988)

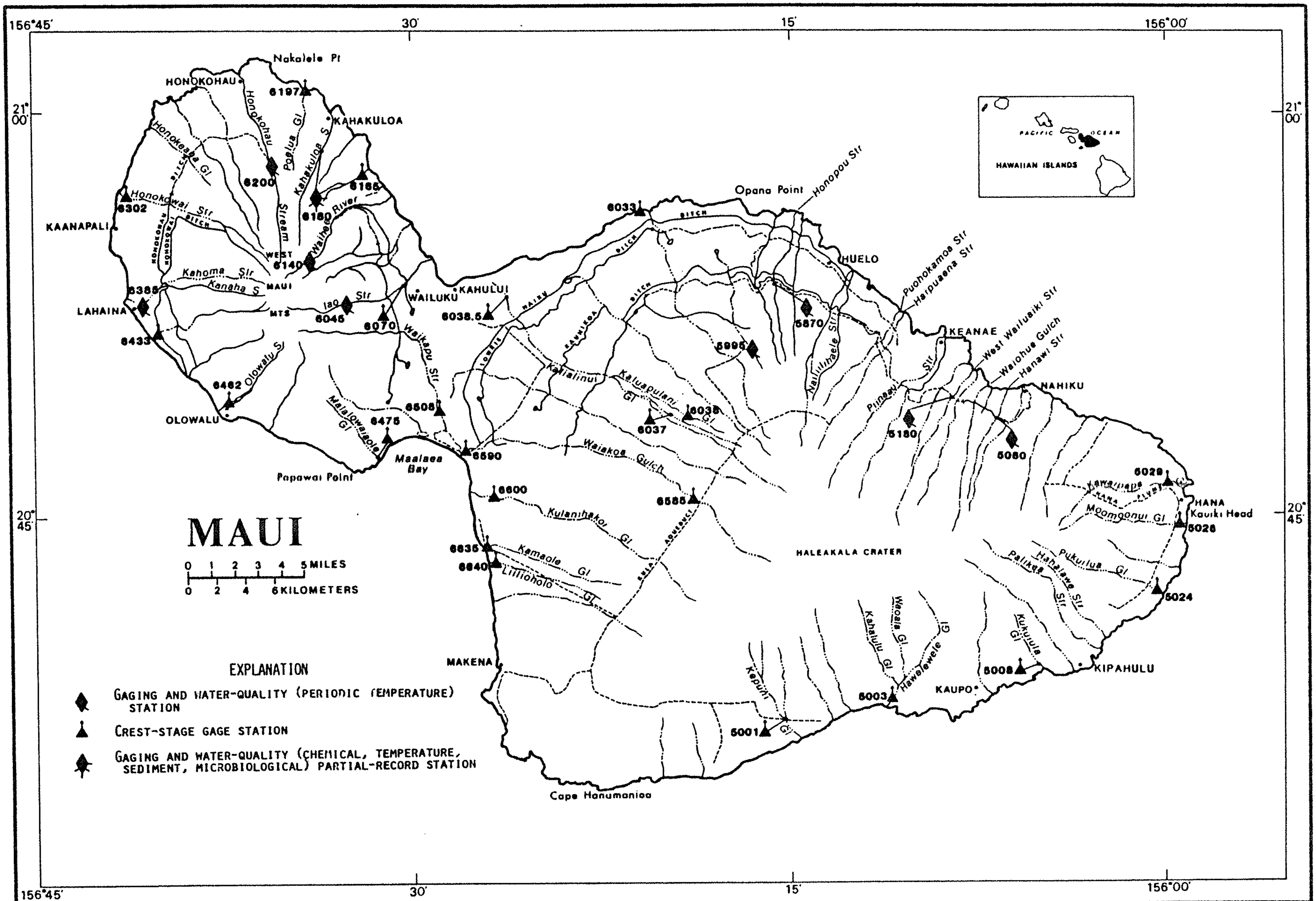


FIGURE 8.--LOCATIONS OF GAGING, WATER-QUALITY, AND PARTIAL-RECORD STATIONS ON MAUI.

Source: USGS Water Data Report HI-88-1

Map 2 Gaging Stations (1988)

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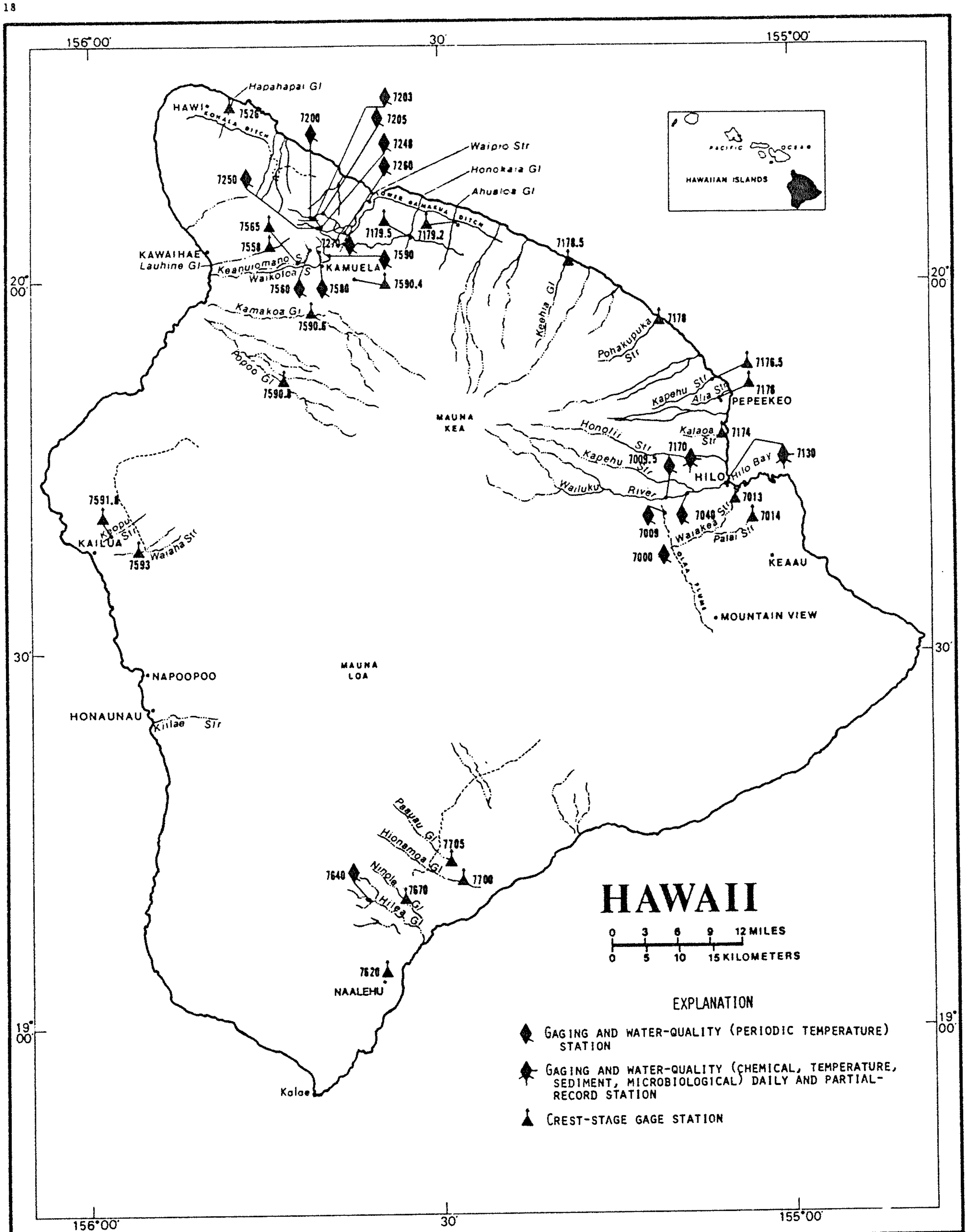

FIGURE 10.--LOCATIONS OF GAGING, WATER-QUALITY, AND PARTIAL-RECORD STATIONS ON HAWAII.

Source: USGS Water Data Report HI-88-1

Water Quality

Water quality monitoring is an essential part of any evaluation of water for health, safety and habitat protection. Results of monitoring aid in the assessment of mitigation and management practices. The type of water quality information collected varies depending on the user's need.

Information on surface water quality has been collected in Hawaii since the 1960s. Most agencies collect water quality data to meet specific goals that are usually problem-oriented and of short duration.

Monitoring of stream water is best done at instream stations, however testing of nearshore waters may provide information about the water quality of streams that enter those waters. A list of these nearshore monitoring sites and associated streams is provided.

This report is an inventory of water quality efforts only. It makes no attempt to provide the data itself, or to assess the quality of Hawaii's surface or nearshore water. HSA provides an index of the type of water quality information that has been collected (physical, chemical, biological, and sediment), the dates collected and sources of that information.

Background

Independent surface water quality monitoring programs were initiated in the 1960s by the U.S. Geological Survey, State Department of Health, Honolulu Board of Water Supply and USFWS. A program was initiated by the University of Hawaii at Hilo in 1987 for Hilo Bay and related nearshore waters. Monitoring reached its peak in the 1970s. Currently it is at a relatively low level.

United States Geological Survey: The USGS has collected water quality information at stream gaging stations since 1967 as part of a nationwide program. This program records basic water quality characteristics, noting long-term changes in the quality of water for monitoring and prediction purposes. This comprehensive survey is conducted at the six National Stream Quality Accounting Network (NASQAN) stations, which are "data-collection facilities for obtaining regional and nationwide overviews of the quality of our streams" (USGS 1977), and at the one Hydrologic Benchmark station. A Benchmark station is more specific than a NASQAN station, in that it is located in a water basin which is anticipated to remain in a natural condition. Physical, biological and chemical information is collected at these stations. Less comprehensive water quality information is usually collected at other stations. In addition to these regular programs, USGS collects information on a special project basis.

State Department of Health: The DOH is responsible for monitoring the quality of water used for consumptive or recreational purpose and has different standards for acceptable levels of contaminants, depending on the use. DOH drinking water quality monitoring focuses on groundwater, which is the primary source of Hawaii's potable water supply. The various county water departments cooperate with the DOH in monitoring drinking water. The DOH also identifies Water Quality Limited Segments which are waterbodies within the state which, without additional action to control non-point source of pollution, cannot reasonably be expected to attain or maintain State Water Quality Standards.

The DOH also monitors chemical and biological pollutant levels in some nearshore waters, for the health and safety of recreational users. When monitoring is conducted in the receiving water of specifically identified streams, this may provide information on stream water quality.

The Honolulu Board of Water Supply: This is the only county water department that independently maintains surface water quality records. The BWS collects physical, chemical and biological records for the Lulumahu stream, a tributary of the Nuuanu Stream, and at the Nuuanu Tunnels.

The University of Hawaii at Hilo: UH-Hilo has conducted both instream and near-shore water quality testing in the Hilo area since 1987, primarily to determine water movement.

U.S. Fish and Wildlife Service: The USFWS measured certain heavy metals and organochlorine pesticides in freshwater fish in their National Contaminant Biomonitoring Program from 1976 - 1984.

The DOH and several other agencies have opted to concentrate resources on management rather than monitoring, for reasons of cost and efficiency. "Toxic pollution is difficult and costly to monitor. A single water sample analysis for the U.S. Environmental Protection Agency's 'priority pollutants' costs over $2,000." This issue is "complicated by the difficulty and cost of identifying the specific sources of pollutants which have an impact on receiving waters. At this point in time, monitoring for the sake of recording water quality trends will not greatly help to accomplish this program's goals. Money now is better spent on the implementation of pollution control programs which will help to reduce nonpoint source inputs (DOH 1989). This conclusion corresponds with the Soil Conservation Service (SCS) decision to put resources to study Best Management Practices (BPM) instead of general water quality monitoring.

New, more stringent federal water quality standards for drinking surface water sources take effect in 1991. The consequence of this in Hawaii appears to be the termination wherever possible of surface water sources for consumptive use, so that these new regulations will not necessarily lead to greater monitoring of surface water.

Methods

All the agencies and individuals listed in the Sources section of the report were queried for water quality information. Agencies with water quality information were: USGS, DOH, University of Hawaii at Hilo, and the University of Hawaii at Manoa Water Resources Research Center. The type of information collected varied according to the user's needs and interest. Surface water quality information is inventoried by source, type and dates.

Water Quality Information Types

Physical characteristics include temperature, specific conductance, turbidity, color, odor, pH, and suspended solids. The most common measurement taken is temperature.

Biological characteristics include bacteria (bacteria includes fecal coliform and fecal streptococcus), phytoplankton, zooplankton, periphyton, and macroinvertebrates.

Chemical characteristics include total dissolved solids, major ions, hardness, silica, phosphorus species, nitrogen species, detergents, other minor elements, radiochemical species, organic species, pesticides species, biochemical oxygen demand, chemical oxygen demand, dissolved oxygen, and other dissolved gasses.

Sediment characteristics include suspended sediment concentration, suspended sediment discharge, bed load, total concentration, and particle size and distribution.

This report does not provide the actual water quality testing results (for example, specific levels of chemical analysis), nor does it make any attempt to interpret those results.

The relationship between the nearshore water quality test results and water quality of associated streams is tenuous. Unless streams are discharging into the nearshore waters at the time of sampling, stream water characteristics will not be represented. Therefore information is provided for inventory purposes only.

Aquatic studies often include water quality ratings pertinent to those studies. These have not been included in this water quality monitoring inventory, as they are inconsistent, hard to access, and often not appropriate.

Results

Sixty-five streams have some instream water quality information (Table 7). Of these, 46 stations have physical information only; 19 stations have additional chemical, biological or sediment information. Water quality information is currently being collected at 14 streams. This includes the seven USGS index stations. USGS is currently collecting sediment data from six daily stations on the Halawa and Kaneohe streams on Oahu to quantify sediment yields from highway construction activities.

Distribution of Streams with Water Quality Information
Current and Past Data Collection

	Total #strms	Current #strms
Kauai	10	2
Oahu	25	6
Molokai	6	1
Maui	13	2
Hawaii	11	3

Streams with considerable Water Quality Information

Kauai:	Wailua River, Hanapepe, Waimea
Oahu:	Kaneohe, Kaelepulu Canal, Ala Wai Canal, Nuuanu (Lulumahu), Kalihi, Moanalua, Waikele
Molokai:	Halawa
Maui:	Kahakuloa
Hawaii:	Wailuku, Honolii

The University of Hawaii at Hilo will continue monitoring Hilo Bay and related streams for at least another year or two.

The Honolulu Board of Water Supply plans to expand its water quality monitoring program to include tunnel water sources.

The U.S. Geological Survey plans to continue water quality monitoring at its NASQAN and Benchmark stations as part of its national program. Expansion of this program would have to be with the cooperation of a state or county agency.

USGS Index Stations

Benchmark Station: Honolii Stream, Hawaii
NASQAN Stations:
- Waimea River - Waimea, Kauai
- Waikele Stream - Waipahu, Oahu
- Kalihi Stream - Kalihi, Oahu
- Halawa Stream - near Halawa, Molokai
- Kahakuloa Stream - Kahakuloa, Maui
- Wailuku River - Hilo, Hawaii

CBR Stations: Kalihi, Oahu; Waialae, Kauai

The U.S. Soil Conservation Service (SCS) has undertaken a National Initiative on Water Quality mitigation. Its purpose is to determine best management practices to control erosion and sedimentation. The SCS has prioritized five hydrologic units for this initiative. SCS is pursuing funding for this program for fiscal year 1991.

The SCS National Initiative on Water Quality Mitigation areas
for mitigation efforts and study

Maunawili/Waimanalo, Oahu - special project
Maunawainui, Molokai - hydrologic unit project
Waialua-Kaiaka Bay, Oahu - hydrologic unit project
North Kohala, Hawaii - Demonstration project

The USFWS program documented some of the highest concentrations of contaminents (metal and organochlorine) in the country in fish collected from Manoa and Waikele Streams on Oahu from 1976 - 1984.

The DOH has decided to concentrate its surface water quality monitoring efforts in "Water Quality-Limited Segments" of nearshore waters. These are coastal areas which have water quality problems from nonpoint source pollution sources, much of which is carried to the ocean in the stream. The DOH has targeted these segments for testing to obtain baseline information on the type and level of pollution. This may be relevant to instream water quality when the receiving waters can be associated with a particular stream. The DOH will continue, increase or initiate monitoring of most of the segments and other nearshore areas as funds and laboratory time allow.

DOH Water Quality-Limited Segments and DOH Water Quality rating 1989 and associated streams

Station location, Island, DOH water quality rating (A,AA) (associated streams)
AA = Objective that water remain in their natural, pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused source or action.
A = Objective that the use of these waters for recreational and aesthetic purposes be protected. (DOH 1988)

Ala Wai Canal, Oahu, A (Makiki, Manoa, Palolo)
Hanapepe Bay, Kauai, A (Hanapepe River)
Hilo Bay, Hawaii, A (Wailoa, Wailuku, etc)
Honolulu Harbor, Oahu, (Kapalama, Nuuanu)
Kahana Bay, Oahu, AA (Kahana River)
Kaneohe Bay, Oahu, A-AA, (Heeia)
Keehi Lagoon, Oahu, A (Kalihi, Moanalua)
Nawiliwili Bay, Kauai, A (Huleia, Nawiliwili, Puali)
Pearl Harbor, Oahu, A (Aiea, Halawa, Honouliuli, Kalauao, Waiawa, Waikele, Waimalu)
Waialua-Kaiaka Bay, Oahu, A (Anahulu, Kiikii, Paukauila)
Waimea Bay, Kauai A (Waimea)

DOH Nearshore Water Quality Testing Sites

Hanalei River (Kauai) 805, 804, 850
Hanamaulu Stream (Kauai) - 806
Hanapepe River (Kauai) - 861, 821
Kalihiwai (Kauai) - 811
Nawiliwili, Huleia and Puoli streams (Kauai) - 881
Wailua River (Kauai) 818
Waimea River (Kauai) - 823
Ala Wai Canal (Oahu) - 321
Anahulu stream (Oahu)- 170, 171
Heeia Stream - (Oahu) 401, 402, 403, 362
Kahana River - (Oahu) 178
Kaneohe Stream - (Oahu) 190
Punaluu (Oahu) - 177
Olowalu (Maui) - 663
Honolii (Hawaii) 1110
Wailuku and Wailoa (Hawaii) - 1101, 1110, 1107, 1108, 1118

Discussion

While monitoring is costly, it is essential for evaluating the results of mitigation and best management practices. Further, monitoring alone enables detection of long-term changes in water quality.

The current surface water quality monitoring includes testing by USGS at about 14 stations and by DOH's blue waters program, primarily in nearshore waters.

Judging from agency reports, those entrusted with various aspects of water quality appear to agree that nonpoint source pollution is Hawaii's greatest surface water quality problem. Sedimentation is considered a serious, significant threat to Hawaii's surface and nearshore water quality. Methods for monitoring sediments are available and constistent. Monitoring is needed to address this serious concern.

Future Research

A "Network Analysis" for water quality monitoring would be helpful. The CWRM might take the lead in a coordinated effort involving SCS, DOH, USGS, U.S. Army Corps of Engineers and DLNR to produce a long-range monitoring plan. Participation would reduce duplicated effort and possibly encourage more federal financial participation.

Results of the USFWS monitoring program are highly unusual. The elevated levels of contaminants may pose public health and fishery isssues, suggesting priorities be given to update this information.

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Water Supply

Streams provide needed water for many important offstream uses. Surface water from streams is the lifeline for many communities and for much agricultural activity (both large scale and small) in this State. Thus, streams, as suppliers of water for offstream uses, are indeed a resource for the people of Hawaii and, as such, are clearly in the public interest. Streams are vital to our economic and social well-being.

The committee felt that it was important for the HSA to both identify and assess those streams which supply beneficial offstream uses of water. However, the lack of available information that is both complete and reliable rendered this task difficult at the present time. A thorough inventory of surface water use is presently being developed by the Commission on Water Resource Management as part of their water use certification program called for by the State Water Code. Thus, upon completion of the Commission's program, an inventory will be available for use by the HSA. The committee concluded that each stream which supplies water for an offstream use, as confirmed by the water use certification process, should be "tagged" in recognition of the beneficial nature of offstream uses.

Methods

Committee

The Water Supply Committee consisted of representatives of the agricultural community and municipal water suppliers.

Water Supply Committee

Meredith Ching, Chair. Alexander and Baldwin Inc.
Paul Matsuo, Department of Agriculture, Irrigation Division
Herbert Minakami, Honolulu Board of Water Supply
Myrone Murikami, Hawaii Farm Bureau Federation

The Committee identified the major categories of offstream water uses as being: municipal, large-scale agriculture (sugar, pineapple, cattle, etc.), diversified agriculture (including State irrigation systems and taro), and other (small domestic systems, Hawaiian Homes, etc.).

Inventory and Assessment

Lengthy discussions were held on the problems of inventory and assessment. Both tasks were deemed by the committee to be essential for the purpose of this study.

With respect to inventory, it was not possible within the timeframe of this study to conduct a field survey of all uses of stream water in this State. Certain major users of surface water do have comprehensive lists of the streams they utilize. However, for other users, there is little or no information currently available.

With respect to assessment, again lacking information as to the quantities of use, purpose of use, importance/value of the use, etc., the Committee felt it would be difficult to rate the individual streams for their water supply value on a relative basis. Thus, the committee concluded that it would be appropriate for the HSA to "tag" all streams which are used for offstream uses and to recognize offstream uses as being of benefit to the public. This "tagging" will serve as a red flag for subsequent decision makers to investigate in more depth a particular stream's value as a supplier of water.

As a first cut at and example of which streams should be "tagged" as suppliers of beneficial offstream uses, the Committee obtained lists of streams used by the sugar companies and County Boards of Water Supply (Table 10). As these water-users were in the process of filing their declarations of use with the Commission, such information was readily available. These are not intended to be complete lists of all of the streams to be "tagged"---they are illustrative only and subject to supplement and verification pending the results of the Commission's water use certification process.

Results

As explained above, Table 13 lists streams by island utilized by the County Boards of Water supply and by the major sugar companies. This information should be periodically verified and updated with data from the Commission's water use certification program.

Discussion

The identification (assessment) of streams which provide water for offstream uses is critical to any decision to preserve and/or protect streams for their wild and scenic value as part of the public trust. If offstream uses are precluded, there is a cost to the public which must be considered. Just as the aquatic, riparian, cultural or recreational value of leaving water in a stream is to be considered, so should the economic or social value using the water offstream. All of these values need to be balanced as a part of the decision-making process to potentially designate wild and scenic streams.

The appropriate water supply inventory is being developed and put on database by the Commission on Water Resource Management. This information will ultimately be merged into the HSA database, thus effectuating the "tagging" process and creating a combined bank of data which will be a powerful tool for the Commission and other planners.

Sources

This entire section was provided by the Chair of the Water Supply Committee, Meredith Ching.

Table 10 Water Supply for Counties and Agriculture

(Information supplied by the Water Supply Committee. Use may also include tributaries of these streams.)

Code		HSA Stream Code	LPC	Lihue Plantation Company
Name		HSA Stream Name	MKSC	Mauna Kea Sugar Company
County	Y	County Water Supply Source	MSC	McBryde Sugar Company
Ag		Large Agricultural Company Diversion	OS	Olokele Sugar Company
	HSC	Hamakua Sugar Company	OSC	Oahu Sugar Company
	HCSC	Hawaiian and Commercial Sugar Co	PMSC	Pioneer Mill Sugar Company
	KAC	Ka'u Agribusiness	WAC	Wailuku Agribusiness
	KSC	Kekaha Sugar Company	WSC	Wailua Sugar Company

Code	Name	County	Ag
Kauai			
2-1-14	Wainiha R.		MSC
2-1-16	Waikoko		LPC
2-1-19	Hanalei R.		LPC
2-2-01	Anahola		LPC
2-2-04	Kapaa		LPC
2-2-08s	Wailua S.		LPC
2-2-12	Hanamaulu		LPC
2-2-15	Huleia		MSC
2-3-02	Waikomo	Y	MSC
2-3-04	Lawai		MSC
2-3-06	Wahiawa		MSC
2-3-07	Hanapepe		MSC,OS
2-4-04s	Waimea S.		KSC
Oahu			
3-1-18	Kahana		OSC
3-2-02	Waikane		OSC
3-2-04	Waiahole		OSC
3-4-06	Waiawa		OSC
3-4-10	Waikele		OSC
3-4-11	Honouliuli		OSC
3-6-06s	Kiikii S.		WSC
3-6-07s	Paukauila S.		WSC
3-6-08s	Anahulu S.		WSC
Maui			
6-1-01	Ukumehame		PMSC
6-1-02	Olowalu		PMSC
6-1-04	Kauaula		PMSC
6-1-05	Kahoma	Y	PMSC

Code	Name	County	Ag
6-1-07	Honokowai		PMSC
6-1-09	Honokahua		PMSC
6-1-10	Honolua		PMSC
6-1-11	Honokohau	Y	PMSC
6-2-06	Makamakaole		WAC
6-2-07	Waihee R.		WAC,HCSC
6-2-08	Waiehu		WAC,HCSC
6-2-09	Iao		WAC,HCSC
6-2-10	Waikapu		WAC,HCSC
6-3-01	Maliko		HCSC
6-3-02	Kuiaha		HCSC
6-3-03	Kaupakulua		HCSC
6-3-05	Uaoa		HCSC
6-3-08	Honopou	Y	HCSC
6-3-09	Hoolawa	Y	HCSC
6-3-10	Waipio	Y	HCSC
6-3-11	Hanehoi	Y	HCSC
6-3-12	Hoalua	Y	HCSC
6-3-14	Kailua	Y	HCSC
6-3-15	Nailiilihaele	Y	HCSC
6-4-01	Oopuola	Y	HCSC
6-4-02	Kaaiea	Y	HCSC
6-4-03	Kolea	Y	HCSC
6-4-04	Waikamoi	Y	HCSC
6-4-06	Puohokamoa	Y	HCSC
6-4-07	Haipuaena	Y	HCSC
6-4-08	Punalau	Y	HCSC
6-4-09	Honomanu	Y	HCSC
6-4-10	Nuaailua	Y	HCSC

Code	Name	County	Ag
6-4-11	Piinaau	Y	HCSC
6-4-13	Waiokamilo	Y	HCSC
6-4-14	Wailuanui	Y	HCSC
6-4-15	W. Wailuaiki	Y	HCSC
6-4-16	E. Wailuaiki	Y	HCSC
6-4-17	Kopiliula	Y	HCSC
6-4-18	Waiohue Gl.	Y	HCSC
6-4-19	Paakea	Y	HCSC
6-4-20	Waiaaka	Y	HCSC
6-4-21	Kapaula	Y	HCSC
6-4-22	Hanawi	Y	HCSC
6-4-23	Makapipi	Y	HCSC
6-5-07	Wailua	Y	
Hawaii			
8-1-32	Punalulu		KAC
8-1-45	Lalakea		HSC
8-1-47	Waiulili		HSC
8-1-51	Waikoloa	Y	HSC
8-1-77	Waipunalau Gl		HSC
8-1-78	Paauilo		HSC
8-1-82	Kukaiau		HSC
8-1-85	Kaala		HSC
8-1-86	Kealakaha		HSC
8-1-89	Kaiwiki		MKAC
8-1-90	Kaula		HSC
8-2-02	Kaawalii		HSC
8-2-03	Waipunalei		HSC
8-2-04	Laupahoehoe		HSC
8-2-05	Kilau		HSC
8-2-06	Manowaiopae		HSC
8-2-07	Kuwaikahi		HSC
8-2-08	Kihalani		HSC
8-2-09	Kaiwilahilahi		HSC
8-2-11	Pahale		HSC
8-2-12	Kapehu		HSC
8-2-13	Paeohe		HSC
8-2-14	Maulua		HSC

Code	Name	County	Ag
8-2-16	Pohakupuka		HSC
8-2-17	Kulanakii		HSC
8-2-18	Ahole		HSC
8-2-19	Poupou		MKAC
8-2-20	Manoloa		MKAC
8-2-21	Ninole		MKAC
8-2-22	Kaaheiki		MKAC
8-2-23	Waikolu		MKAC
8-2-24	Waikaumalo		MKAC
8-2-26	Waiehu		MKAC
8-2-27	Nanue		MKAC
8-2-28	Opea		MKAC
8-2-29	Peleau		MKAC
8-2-30	Umauma		MKAC
8-2-31	Kamaee		MKAC
8-2-32	Hakalau		MKAC
8-2-33	Kolekole		MKAC
8-2-34	Paheehee		MKAC
8-2-35	Honomu		MKAC
8-2-37	Kapehu		MKAC
8-2-38	Makea		MKAC
8-2-39	Alia		MKAC
8-2-40	Makahanaloa		MKAC
8-2-41	Waimaauou		MKAC
8-2-42	Waiaama		MKAC
8-2-43	Kawainui		MKAC,HSC
8-2-45	Alakahi		MKAC,HSC
8-2-47	Kalaoa		MKAC
8-2-49	Kaieie		MKAC
8-2-50	Puuokalepa		MKAC
8-2-53	Kapue		MKAC
8-2-54	Pahoehoe		MKAC
8-2-56	Honolii		MKAC
8-2-57	Maili		MKAC
8-2-59	Pukihae		MKAC
8-2-60	Wailuku R.	Y	

Dams and Diversions

Dams and diversions are common modifications in Hawaii's streams. For this study, dams are those listed by the U.S. Army Corps of Engineers (COE), and diversions refer to weirs that span the streambed, directing water into ditch systems. Other diversions such as small *auwai* and pipes, which can also affect the instream flow, are not inventoried.

Hawaii's major ditch systems are significant physical and historic features. They have allowed agriculture and settlement on otherwise arid land. They have been essential to the success of the sugar industry, a foundation of Hawaii's economy and social patterns for almost a hundred years. Some counties depend on surface water for municipal use. Today's landscape is highly altered by and dependent on these systems.

At the same time, these diversions can be detrimental to instream values. They reduce the instream flow, which in turn can alter the flow characteristics and chemical and physical nature of the water and stream bed. Aquatic and recreational values are usually reduced as a result of diversions and dams. When diversions are at upper elevations and the stream gains flow below the diversion by spring or feeder tributary, or when there is a conservation flow, the impact to the stream is lessened. Diversions at the lower elevations that interrupt streams have significantly greater impact on instream resources.

About a hundred streams are listed by the HSA as having dams or diversions. Because the HSA definitions are limited, this is only a portion of the actual inventory of dams and diversions. The DLNR water use certification program, scheduled for completion in 1991, will provide verified information.

Background

Early Hawaiians depended almost exclusively on surface water for irrigation and domestic use. Their sophisticated and extensive irrigation systems watered crops which were a major part of the landscape and culture. The subsequent development of irrigation systems by sugar companies differed from these earlier ones in capacity and in distance water was removed from the water source.

The first sugar irrigation ditch was built by William H. Rice on Kauai in 1856, and it was not very large or successful. Larger systems were built starting in the 1870s. They were the key to the success of sugar in Hawaii. Most existing systems were in place by 1930. The first great ditch, the Hamakua, was built on Maui, in 1878, by Alexander and Baldwin. Since then, over a dozen major systems have been developed on the four largest islands. These systems, consisting of tunnels, ditches and flumes, are locally referred to as "ditches." However, the word belies their size.

The diversion structure typical of these ditch systems is a cement weir that diverts most or all of the low and average flow out of the stream. The water is delivered to fields or reservoirs, or, in a few cases, to hydroelectric power plants. In only a few cases does the stream bed itself serve as a significant storage area. Ditch systems usually divert water at upper elevations. In some cases the water is transported within the hydrographic unit, such as the Waialua Sugar Company's system. More often, the water is transported out of the general watershed such as the Waiahole Ditch on Oahu, which takes water from the windward valleys through the Koolau mountains to the leeward Ewa plains. The large and complex East Kauai Irrigation (EKI) system can theoretically take water from Hanalei and deliver it to Lihue. The plains of central Maui are watered from both the East and West Maui mountains. The most impressive of these is the East Maui Irrigation (EMI) system, which may be the largest private water company in the United States.

Methods

Dam information was taken from the U. S. Army Corps of Engineers' 1975 Dam Inventory. Irrigation system information was from the USGS, DOWALD, unpublished reports, and the information provided by the sugar companies through the HSA Water Supply Committee. The various county water departments provided lists of their stream and stream associated water sources. The counties are all primarily dependent on groundwater sources, however the surface sources listed in Table 11 are significant especially on Maui.

Results

The geographic distribution of diversions is directly related to the present and historical cultivation of sugar. For this reason, one third of Oahu's and Hawaii's streams and over one half of Maui's streams are diverted. Conversely, there is very little diversion on Molokai, the eastern part of East Maui, or on the north shore of Kauai.

Table 7 identifies those streams known to be or thought to be dammed or diverted by weir, based on information from the above sources. Based on COE's inventory HSA has identified dams on 24 streams. Table 12 lists historic and active ditch gages and discharge figures. Some of this data are old and therefore may be unreliable for current use. Table 11 lists other sources of county water supply.

Table 11 County Water Supply Sources

Oahu
Tunnels:
- Waianae Plantation Tunnels
- Waianae Tunnel
- Waimanalo Tunnels I,II, III, IV
- Luluku Tunnel
- Haiku Tunnel
- Kahaluu Tunnel
- Kalihi Tunnel III, IV, V, VI
- Alewa Hts. Spring
- Nuuanu Tunnel III, IIIA, IV, IVB

Booth Spring
Makiki Spring
Herring Spring
Manoa Tunnel III
Palolo Tunnel

Molokai

Tunnels:

Molokai Tunnel

Maui

Ditches:

East Maui Irrigation
Hailimaili -Kamole Weir
Makawao
Pukalani
Haiku
Honokohau Ditch
Aleoloa Ditch
Kanaha Ditch
Awalau System

Tunnels:

Iao Tunnel

Discussion

Limitations

The complexity of the irrigation systems and limited data on their current condition precludes any attempt to identify individual stream diversions or to suggest that they are all functional. Several of the major historic irrigation systems are known to be in disrepair. Examples are sections of Kohala Ditch, Upper Hamakua Ditch and the Hanalei Tunnel. This project has not attempted to inventory the many smaller private water systems, diversions etc. It is anticipated that these will be recorded by the DLNR under the water use certification program, scheduled for completion in 1991.

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Table 12 Ditch Gages

Ditch Name	Name of Ditch	Quality	USGS assessment of record quality
Gage #	USGS Gage	e	Excellent
Status a	Gage active in 1989	g	Good
Average	Average Flow (cfs) at gaging station	f	Fair
Median	Median Flow (cfs) at gaging station	p	Poor
		Years	Years of Record
		*	EMI maintains recording station

Note: cfs × 0.646 = MGD

Ditch Name	Gage #	Status	Average	Median	Quality	Years
Kauai						
Aahoaka D	070000					66-72
Anahola D	086000					15-21
Anahola D	087000		4.51	0.50	g	36-
Anahola D	088000	a	4.32	2.90	g	21-
China Ditch	102000		27.20	29.00		11-
Hanalei D	099500					56-62
Hanalei Tunnel	100000		27.30	28.00		32-
Hanamaulu D	058000		29.60	32.00		10-20
Hanapepe D	043000		42.50	44.00		30-38
Hanapepe D	044000		38.50	39.00		10-49
Hanapepe D	046000					12-17
Hanapepe D	042000					11-15
Ka Loko D	094200		5.71	3.80		32-68
Kalihiwai D	095900			4.30		60-68
Kalihiwai D	096000		4.08	2.80		34-67
Kanaha D	064000			2.40		10-55
Kapahi D	079000	a		4.50		09-
Kekaha D	027000			51.00		08-34
Kekaha D	022000			55.00		09-68
Kokee D	014000		20.00	24.20	g	26-
Koloa D.	054200		21.30	15.00	g	46-71
Kuna D	104000					12-19
Lihue D	057000			9.20		10-19
Lower Anahola D	090000					09-14
Lower Anahola D	091000	a	2.73	2.70	g	36-
Lower Haiku D.	053600		8.09	3.30	g	63-71
Makaleiha D	077000	a	6.84	7.30	g	36-
North Wailua D	061200	a	23.30	24.00	f	65-
North Wailua D	061000		18.80	19.00	g	32-
Olokele D	032000			66.00		10-17
Olokele D	033000			64.00		12-17
Puu Ka Ele D	095000			3.40		32-67
Ross D	095200			3.10		56-67

Ditch Name	Gage #	Status	Average	Median	Quality	Years
Stable Storm D	062000	a	11.00	0.30	g	36-
Upper Haiku D.	053400		9.01	6.90	g	63-71
Waiahi-Kuia Aq.	056800		6.40	2.10	g	64-71
Wailua D	069000	a	15.90	14.00	g	36-
Waimea D	029000			5.20		11-21
Waimea D	029100		3.91	3.60	g	60-71
Oahu						
Mauka D	203000			3.80		47-68
Moole D	231700			0.10		18-23
Poamoho Tunnel	210900			1.00		58-
Puea Mauka	211850			0.50		60-67
Punaluu D	302000	a	7.03	5.80	p	53-
Waiahole Tunnel	285000			39.00		50-69
Waiahole Tunnel	286000					51-69
Waiahole Tunnel	287000			42.00		51-69
Molokai						
Molokai Tunnel	405100	a	3.97	2.10	g	66-
Molokai Tunnel	405300	a	6.38	4.50	g	65-
Maui						
Center D	561000		21.50	9.60		18-30
Haiku D	594000	a*	24.90	4.70	e	10-
Haipuaena Div.	535000		3.05			38-60
Honokohau D	621000		34.10	36.60		07-13
Honokowai D	629000			6.90		12-67
Kaeluku Flume	503000					40-45
Kahomo Devt.Tun	633000			4.40		11-17
Kauaula D	643000			9.50		11-17
Kauhikoa D	602000		22.70	10.00		10-28
Koolau D	547000		16.90			22-30
Koolau D	512000		34.00	28.00	g	19-
Koolau D	523000		101.00	87.00	g	10-
Koolau D	541000		116.00	93.00	e	32-
Koolau D	551000		107.00	110.00		22-29
Kula Diversion	531000		0.69	0.40	g	45-
Lowrie D	592000	a*	37.30	28.00	g	10-
Lowrie D	591000			0.20		32-47
Makapipi D	506000			4.10		48-66
Manuel Luis D	552500			23.00		30-35
Manuel Luis D	541500		8.13		g	17-

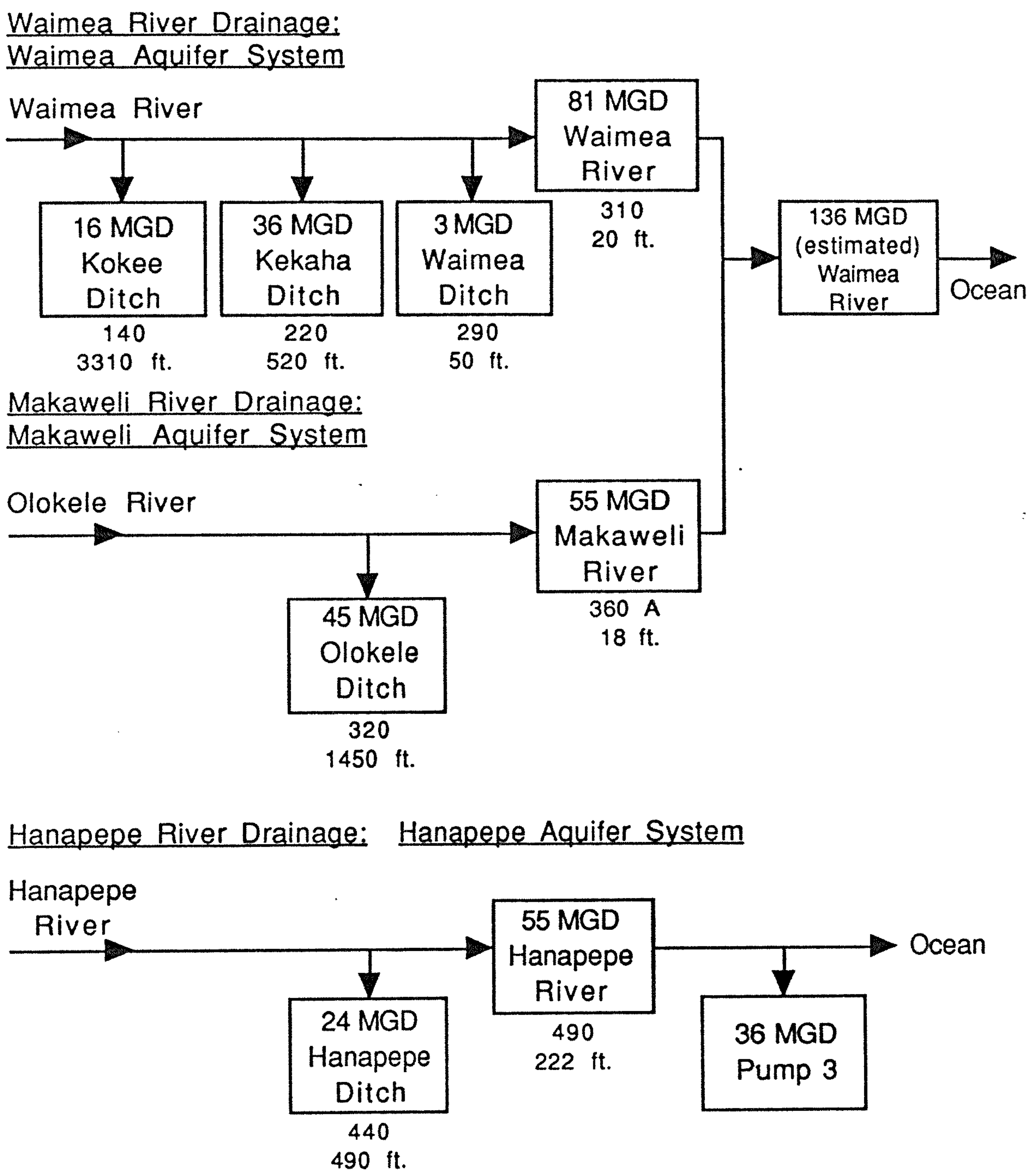
Ditch Name	Gage #	Status	Average	Median	Quality	Years
New Hamakua D	596000		68.70	84.00		10-23
New Hamakua D	589000	a*	36.20	4.90	e	18-
Old Hamakua D	590000		4.12	0.10		18-65
Olowalu D	645000			6.60		11-67
Opana Tunnel	599500	a	3.12	2.00	g	65-
Spreckles D (E)	565500		9.89	2.30		17-30
Spreckles D (E)	552000		12.20	1.50		28-38
Spreckles D (E)	538000					22-
Taro D - Keanae	522000			3.50		34-68
Wailoa D	588000	a*	171.00	170.00	g	22-
Hawaii						
Awini D	744000			0.90		27-72
Awini D	745500		19.40	18.00	g	07-72
Awini D	743000		17.90	16.00	g	27-72
Honokaa Diver.	733200		15.70	16.00	g	64-73
Kehena D	755000			5.60		17-66
Kohala D	752000		33.10	36.00		07-17
Kohala D	751000			38.00		27-72
Kohala D	750000					07-12
Kohala D	750900		37.20	33.00	g	63-72
Lower Hamakua D	733000					64-73
Lower Hamakua D	733100		46.10	46.00	g	64-73
Lower Hamakua D	733101			47.00		65-72
Lower Hamakua D	733300		23.50	24.00	g	64-73
Lower Hamakua D	732900					10-20
Upper Hamakua D	732300					13-20
Upper Hamakua D	727000	a	2.69	0.10	g	77-
Upper Hamakua D	726000	a	11.00	6.60	f	74-
Upper Hamakua D	724800	a	4.98	3.20	g	68-
Upper Hamakua D	720500	a	7.10	4.80	g	64-
Upper Hamakua D	718000		14.80			13-20

Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

KAUAI

Major Stream Diversions



Indicated Flows Are Averages in million gallons/day.
USGS Station Number(abbreviated) and elevation at gage are provided.
"A" indicates gage active 1989.
Flows are based on figures available through water year 1989
Conversion MGD = CFS / 1.5472

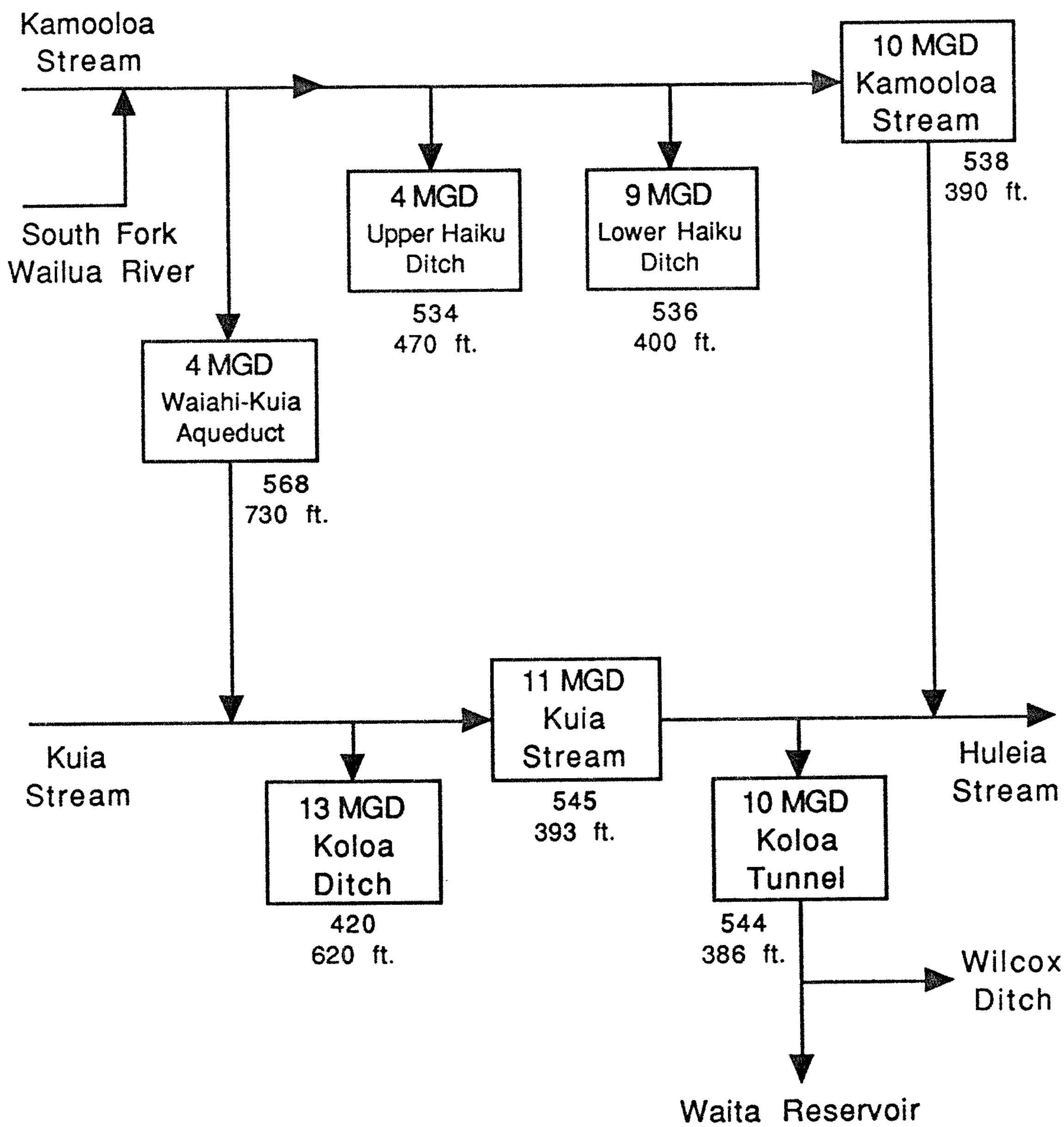
Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

KAUAI

Major Stream Diversions

Streams in Huleia Drainage



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USGS Station Number(abbreviated) and elevation at gage are provided.
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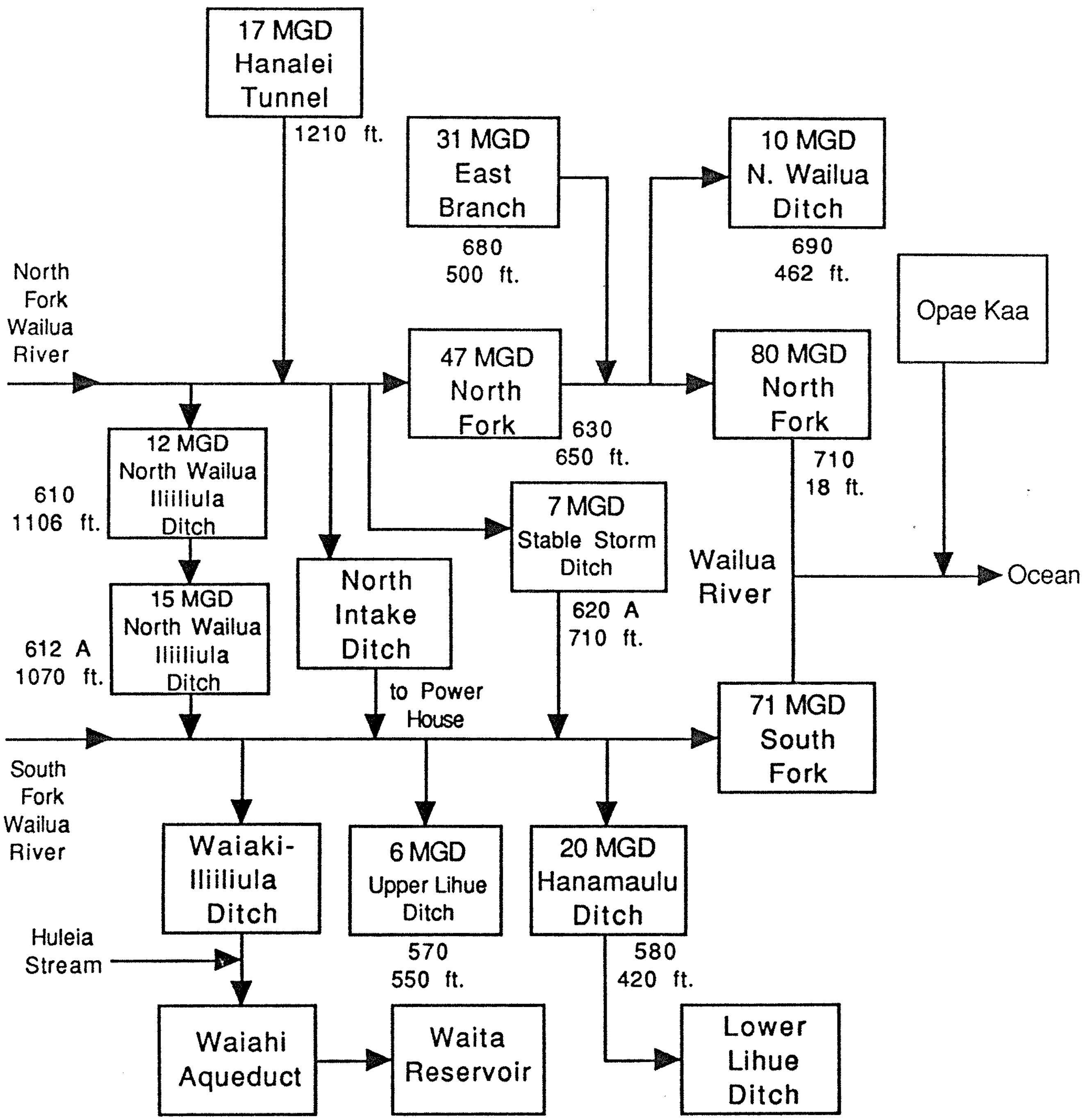
Conversion MGD = CFS / 1.5472

Figure 2 Flowcharts of Major Ditch Systems
From Water Resources Protection Plan, Mink, Yuen, 1990.

KAUAI

Major Stream Diversions

Wailua River Drainage: Wailua Aquifer System



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USGS Station Number(abbreviated) and elevation at gage are provided.
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From Water Resources Protection Plan, Mink, Yuen, 1990.

KAUAI

Major Stream Diversions

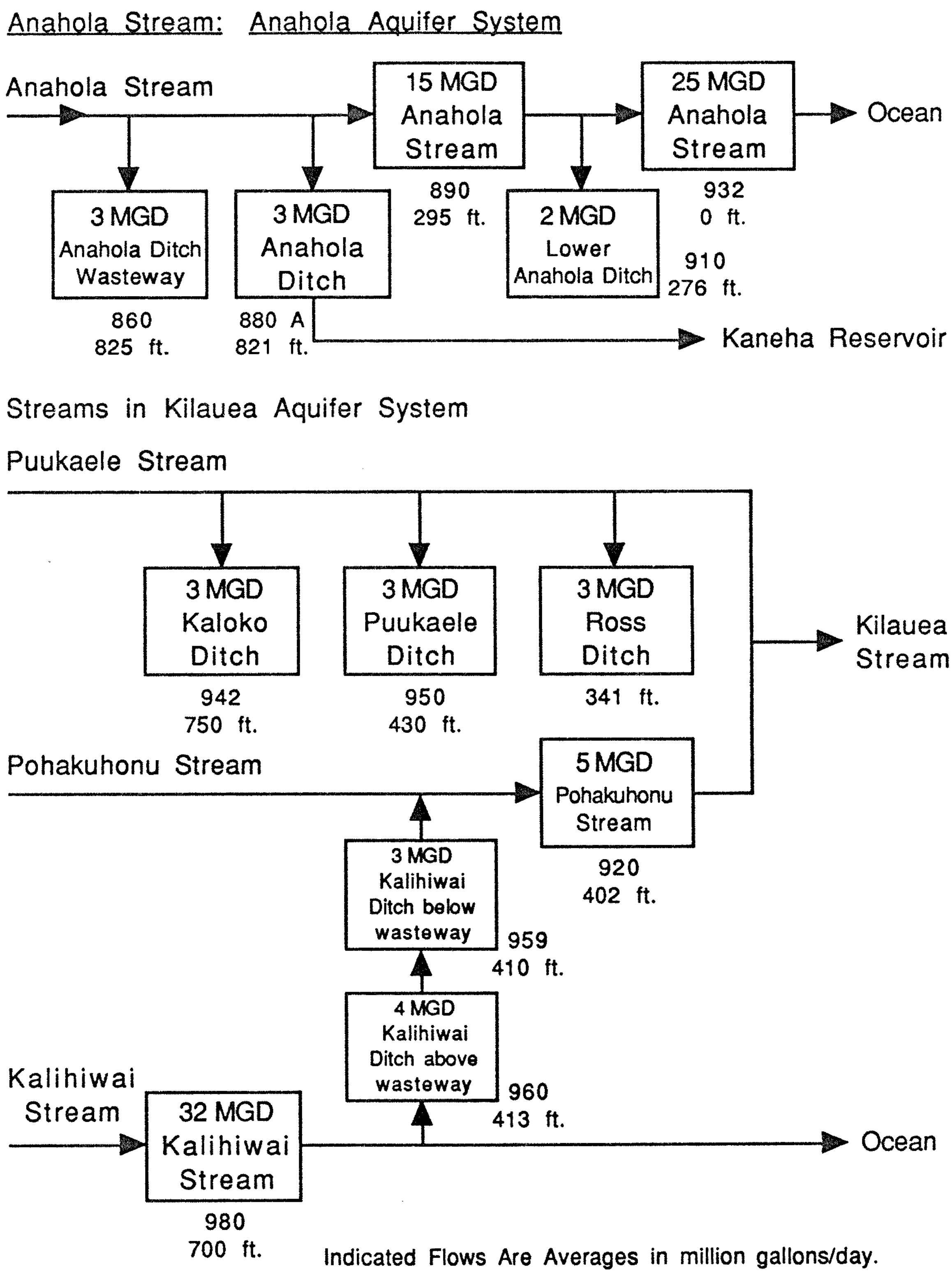

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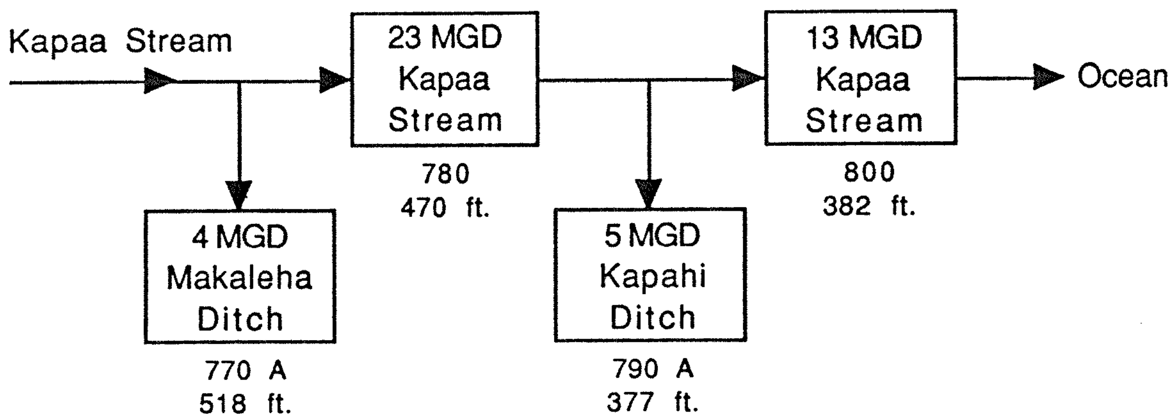
Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

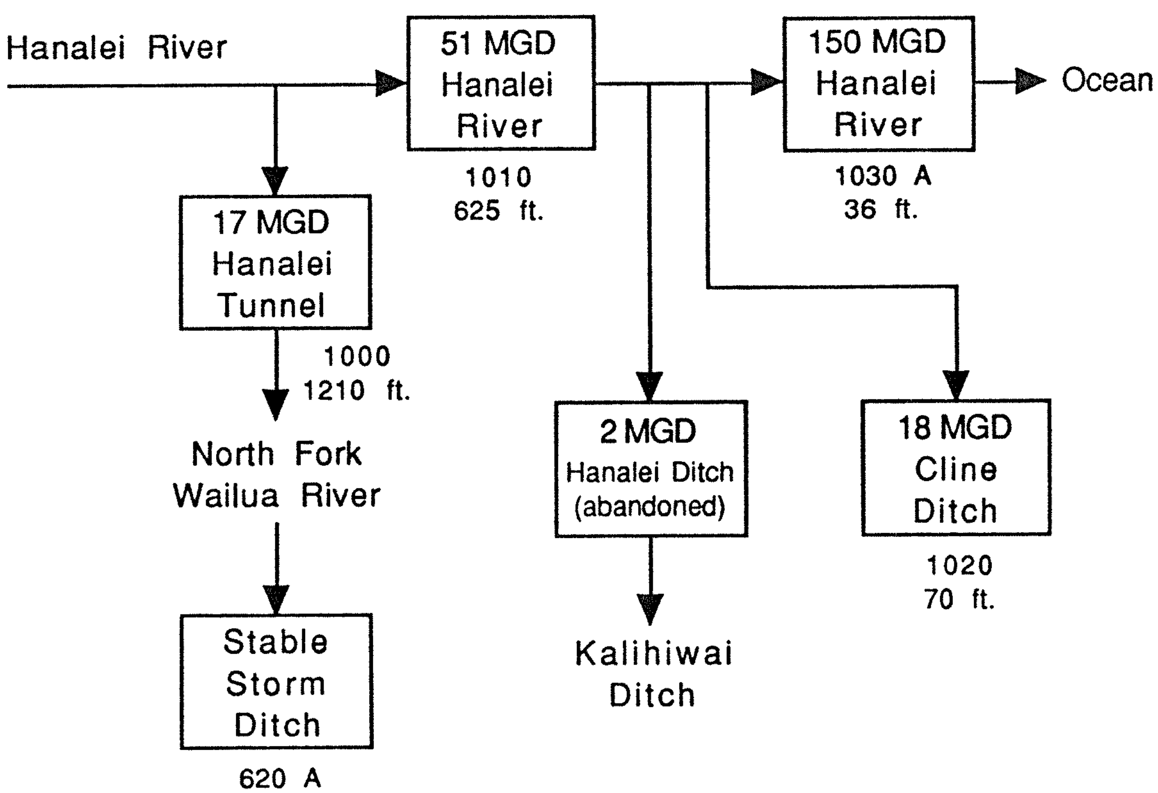
KAUAI

Major Stream Diversions

Kapaa Drainage



Hanalei River:



Indicated Flows Are Averages in million gallons/day.
USGS Station Number(abbreviated) and elevation at gage are provided.
"A" indicates gage active 1989.
Flows are based on figures available through water year 1989.
Conversion MGD = CFS / 1.5472

Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

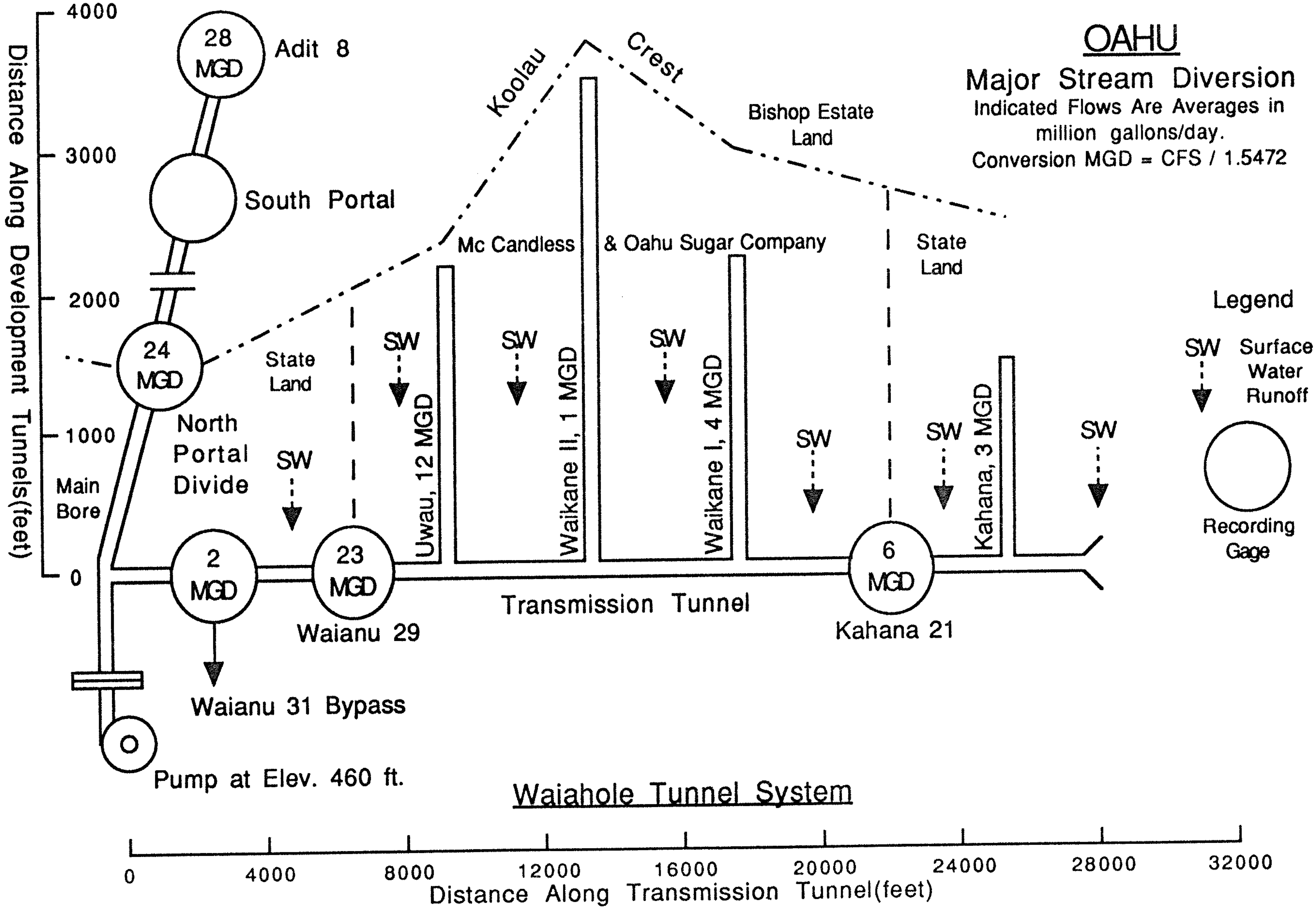


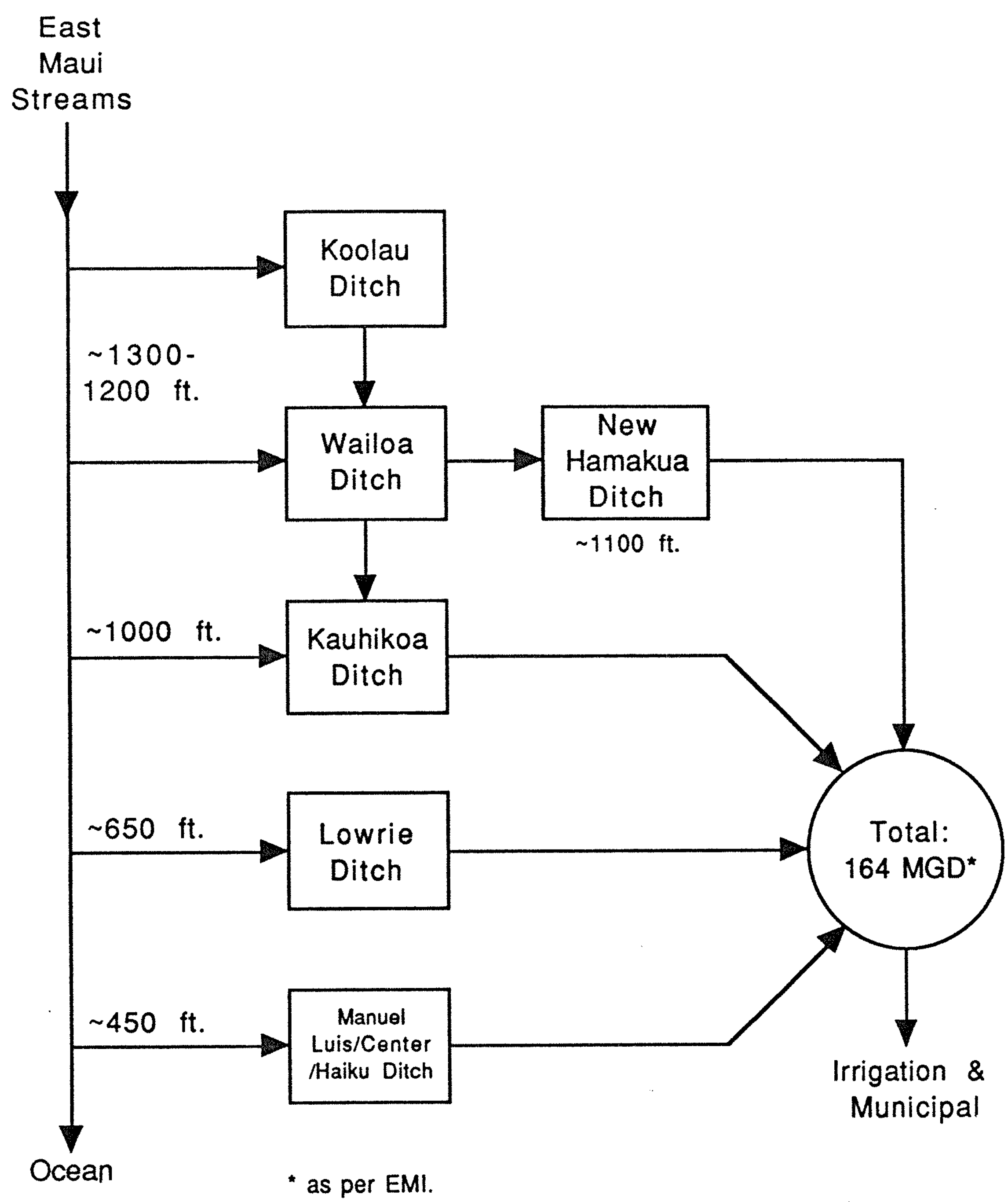
Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

MAUI

Major Stream Diversions

Koolau Aquifer System



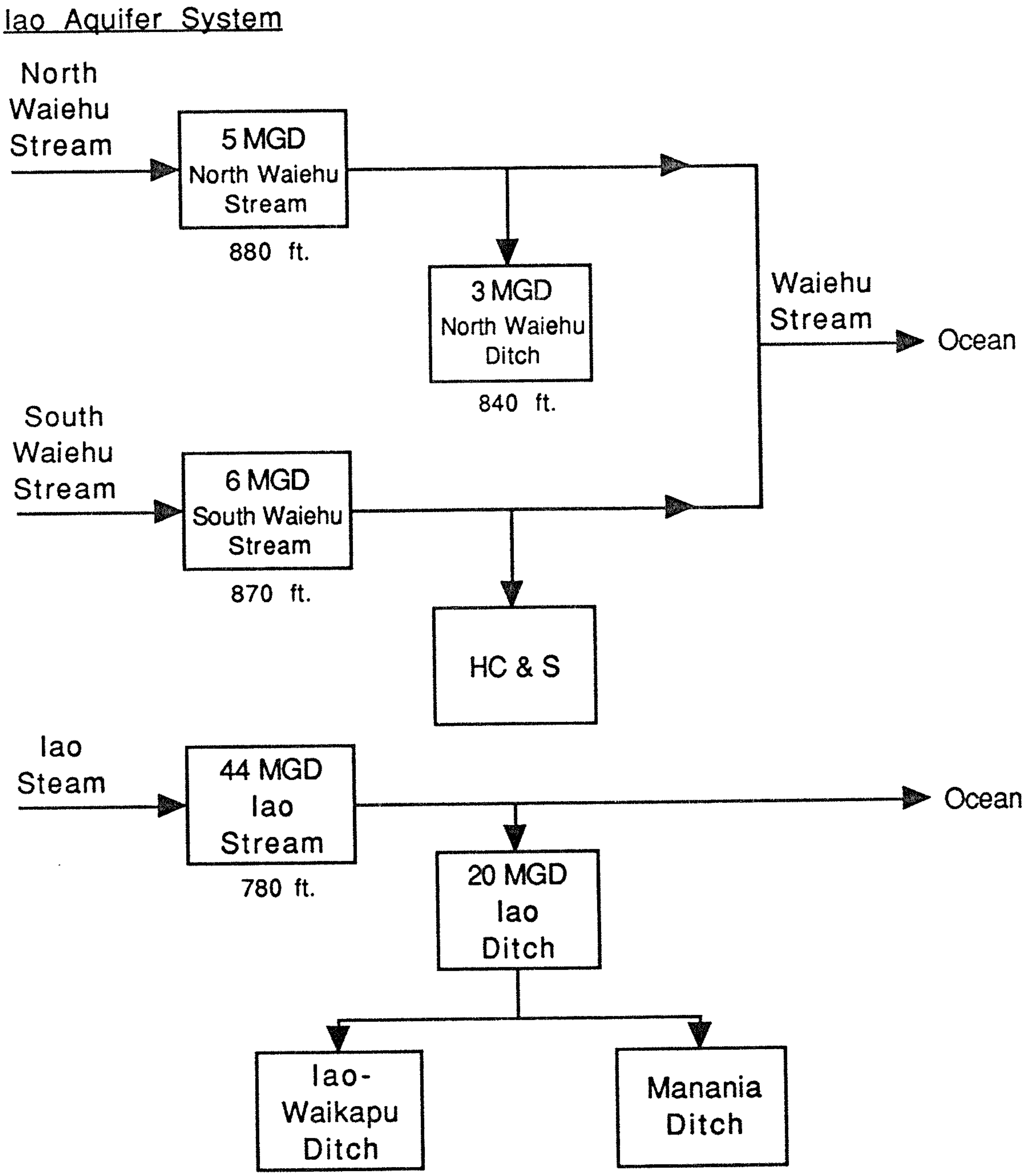
* as per EMI.
Indicated Flows Are Averages in million gallons/day.
USGS Station Number(abbreviated) and elevation at gage are provided.
"A" indicates gage active 1989.
Flows are based on figures available through water year 1989.
Conversion MGD = CFS / 1.5472

Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

MAUI

Major Stream Diversions



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USGS Station Number(abbreviated) and elevation at gage are provided.
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Flows are based on figures available through water year 1989.
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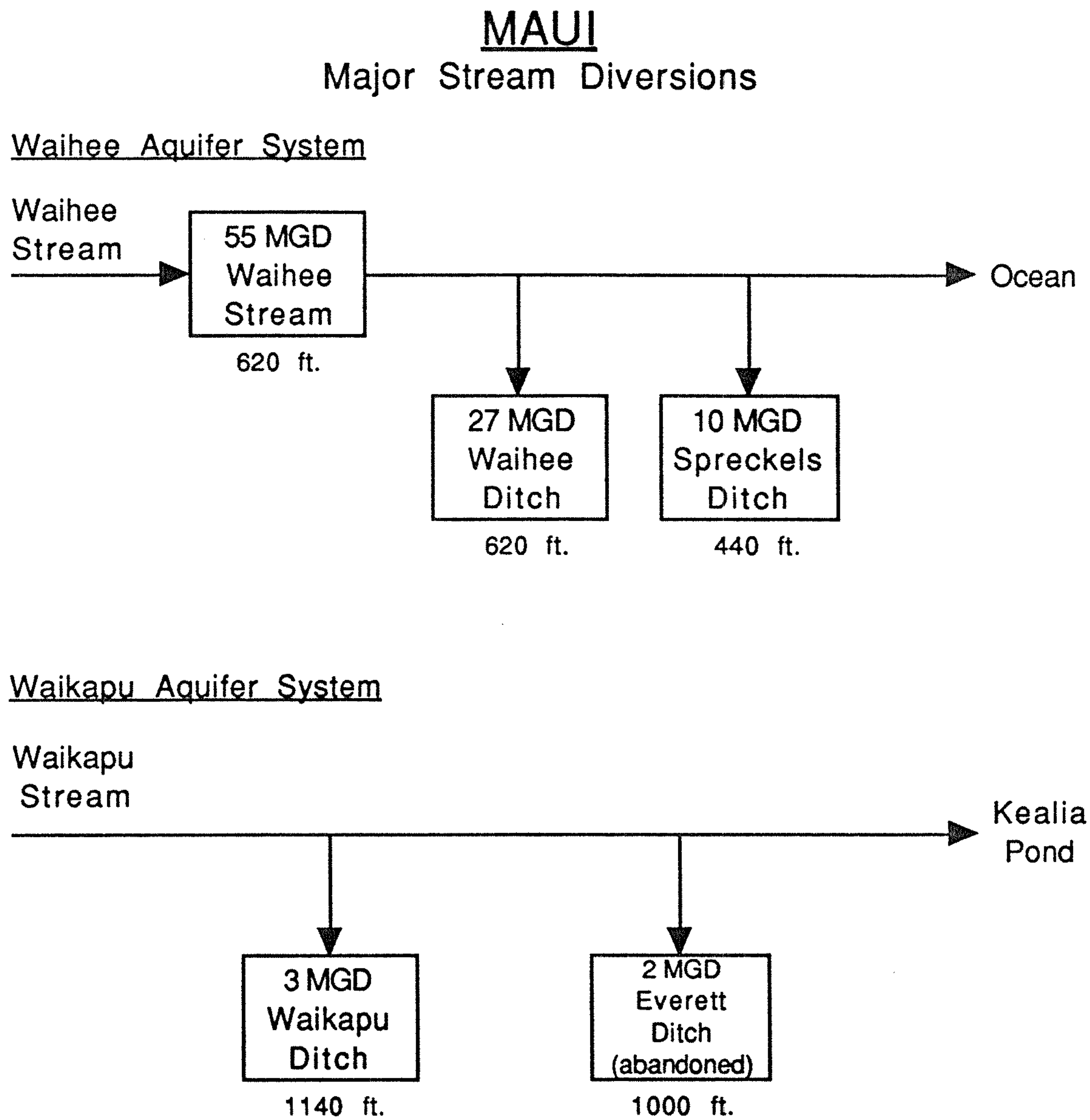
Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.



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Conversion MGD = CFS / 1.5472

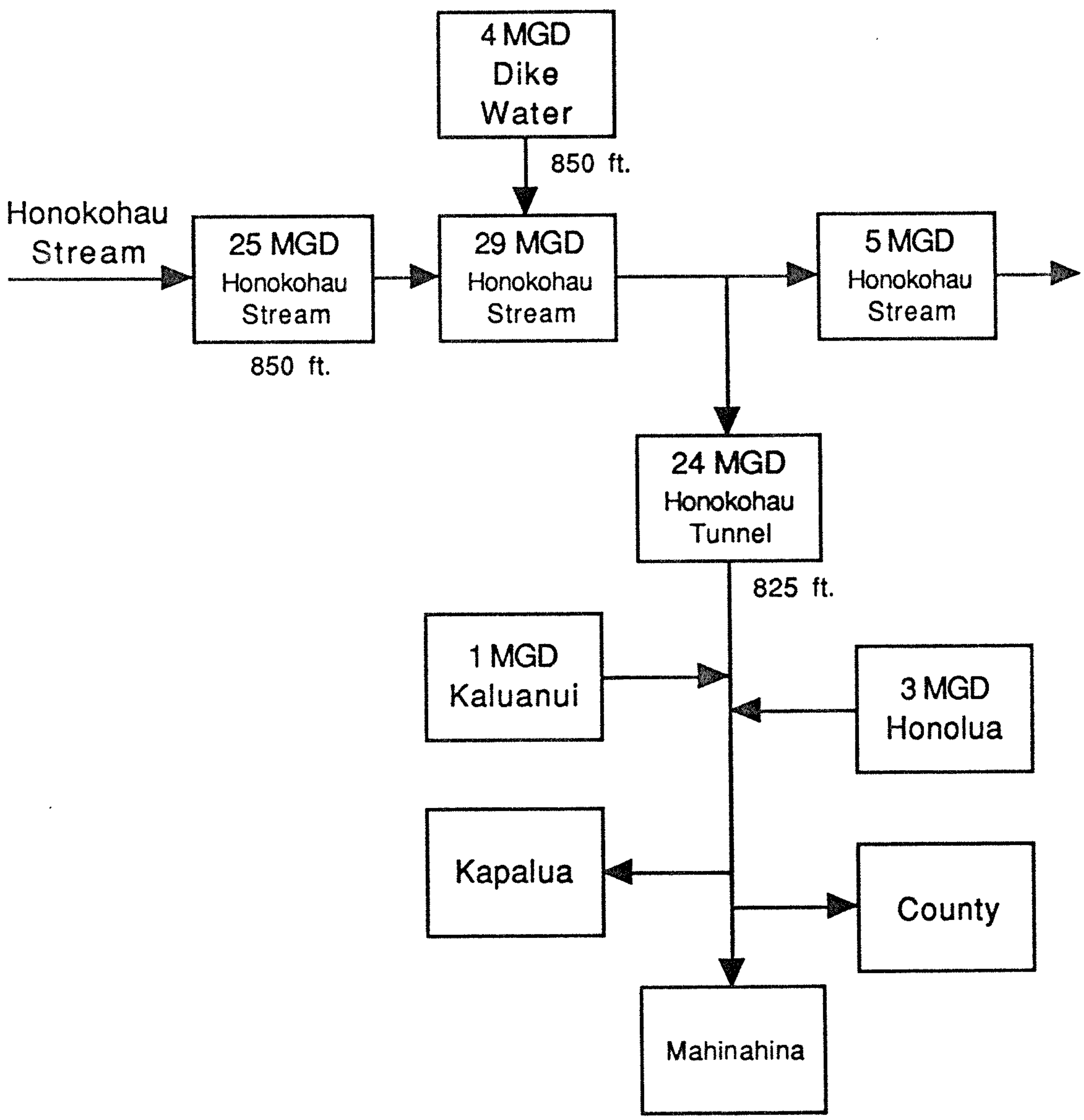
Figure 2 Flowcharts of Major Ditch Systems

From Water Resources Protection Plan, Mink, Yuen, 1990.

MAUI

Major Ditch Systems

C & H



Indicated Flows Are Averages in million gallons/day.
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Conversion MGD = CFS / 1.5472

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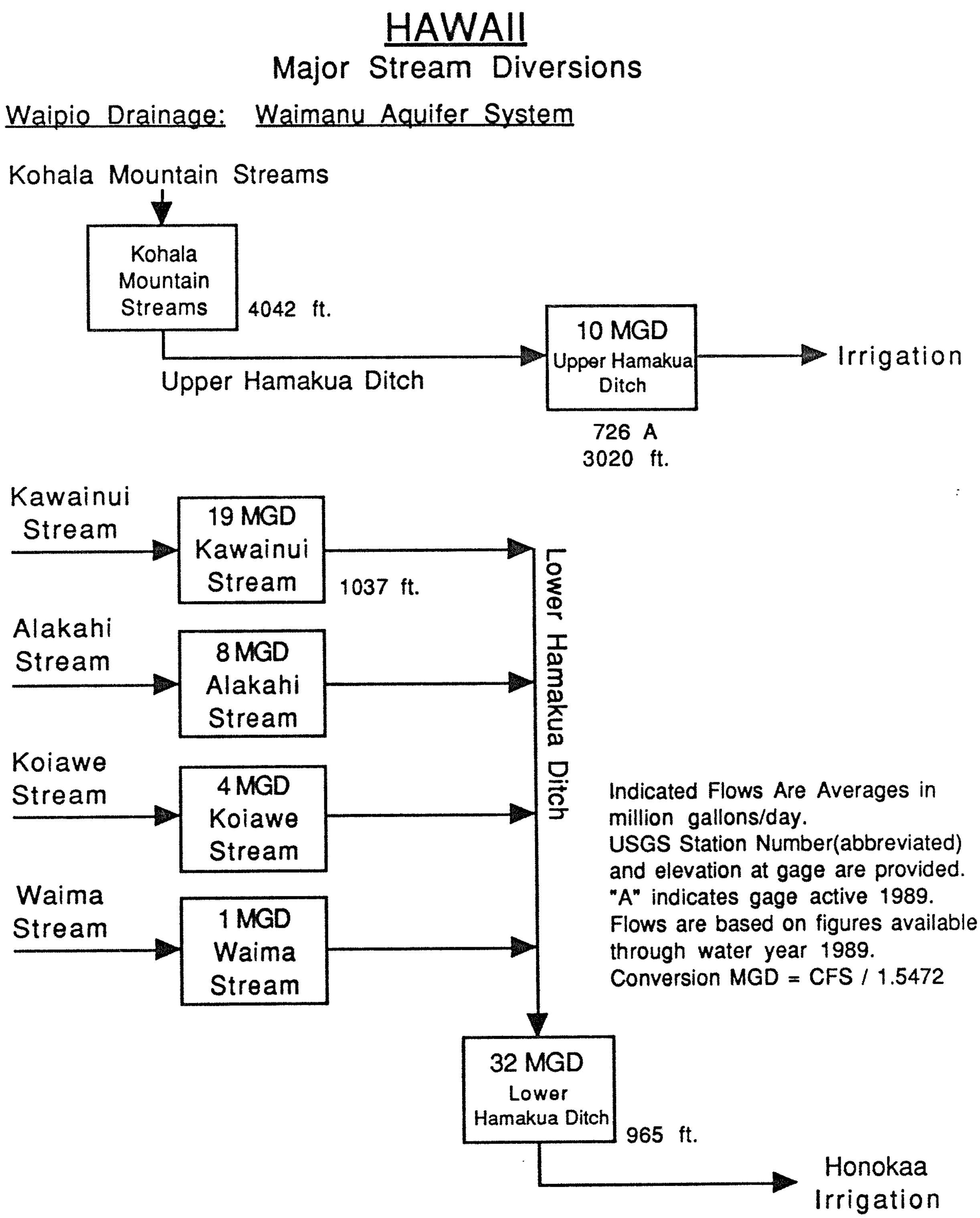


Figure 2 Flowcharts of Major Ditch Systems

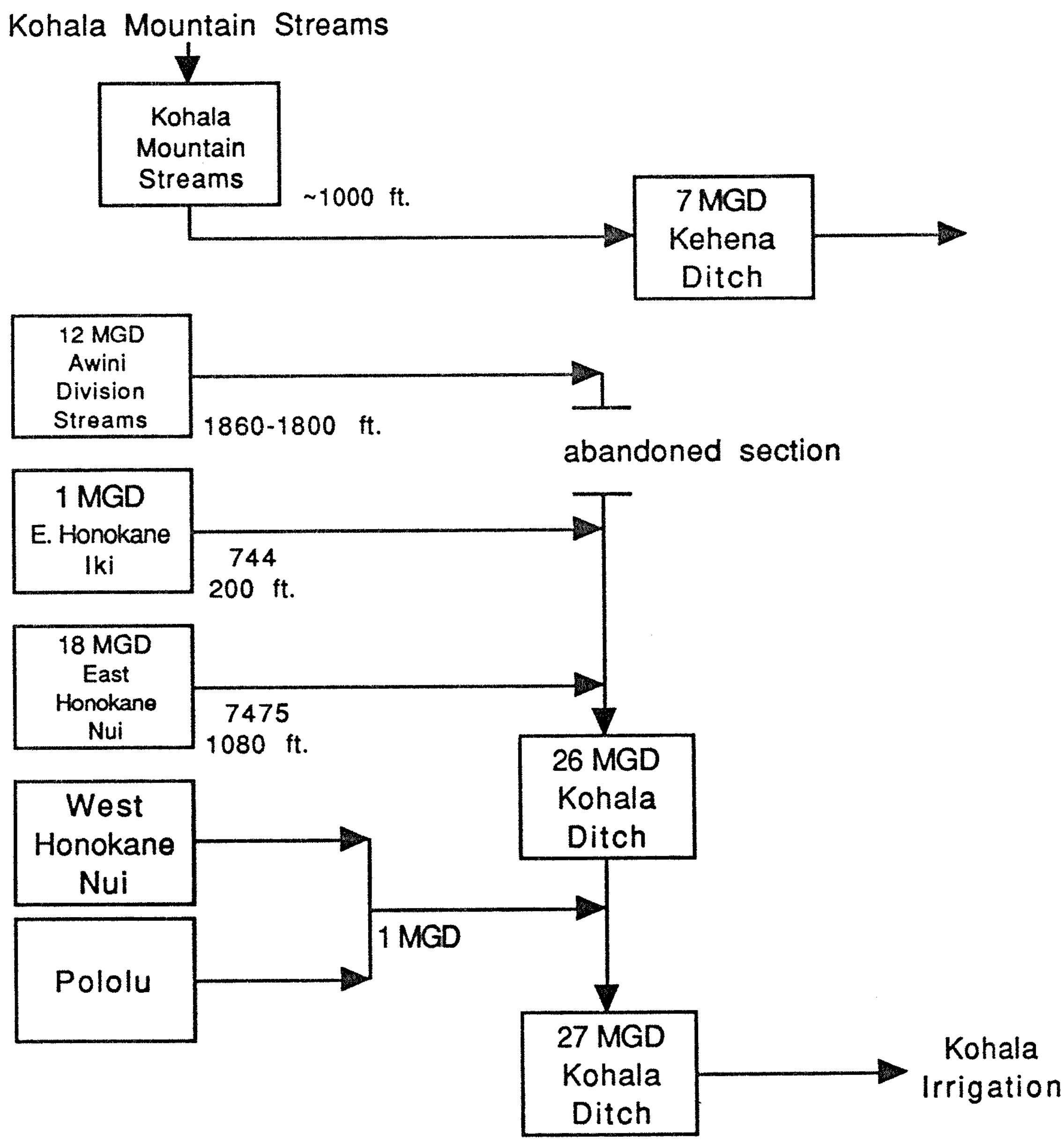
From Water Resources Protection Plan, Mink, Yuen, 1990.

HAWAII

Major Stream Diversions

Kohala Ditch System: Waimanu Aquifer System

Plantation Era



Indicated Flows Are Averages in million gallons/day.
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"A" indicates gage active 1989.
Flows are based on figures available through water year 1989.
Conversion MGD = CFS / 1.5472

Hydroelectric Power

Hydroelectricity is typically generated by instream dams and power generators, but Hawaii's conditions call for a different design. In Hawaii, stream water is diverted to an offstream powerplant. In run-of-the-river designs, water is diverted into ditches, pipes and penstocks to the powerplant, then returned to the river. Other designs position the powerplant along the delivery system to utilize the drop of water (head) to the fields where it is used for irrigation. This water is not returned to the stream.

There are 18 hydroelectric power plants in operation in Hawaii today; seven on Kauai, four on Maui, and seven on Hawaii. Nine additional plants have been proposed, six on Kauai, one on Maui, and two on Hawaii. Hydropower has provided significant (up to 16%) power on Kauai and supplements other sources on Maui and Hawaii. Hydroelectricity currently represents about 1.5% of the state's total electrical energy consumption.

Background

The Hawaii Department of Planning and Economic Development (now DBED), in conjunction with the U.S. Department of Energy, published *Hydroelectric Power in Hawaii: A Reconnaissance Survey*, in 1981. The purpose was to study the potential of developing clean hydroelectric power and thereby reducing Hawaii's dependence on oil. It is a comprehensive inventory of potential sources of hydroelectric power. It considered, among other things, storage, utilization of irrigation systems and reservoirs, upgrading existing facilities and new run-of-the-river plants. The study estimates were based on using all of the stream water and did not take environmental issues into account.

The primary impacts of run-of-the-river hydroelectric on the stream are the diversion itself and the reduction in flow between the diversion and the powerhouse. These changes may also adversely affect water quality, the stream corridor, native habitat and recreational values. The powerhouse itself may entrain and destroy native species. By reducing or eliminating the frequent peak flows typical of Hawaii's streams, the flow regime can be altered from the point of diversion to the sea.

Methods

The Hawaii Stream Assessment has compiled a simple inventory of existing, potential and proposed hydroelectric sites. The primary source for existing sites was the DBED 1988 summary of existing hydroelectric sites in Hawaii. The source for potential sites was the *Hydroelectric Reconnaissance Survey* (DPED 1981) The DBED study identified

28 sites with enough potential to warrant cost/benefit analysis. Proposed hydroelectric sites were taken from the DPED 1988 summary and CDUA applications and Environmental Impact Statements. The figures for energy output occasionally differ for proposed and potential projects because of changes in design.

Results

Of the 18 existing hydropower plants, most were developed and are operated by sugar companies. The two exceptions are on the Wailuku River in Hilo and are operated by HELCO, the local utility. According to the DBED, the 18 existing hydroelectric plants have a total capacity of 18.95 megawatts (MW) and an annual average output of 104.4 million kwh, with a 20 percent variation depending on annual flow (DBED 1988).

In the last several years, hydroelectric development has been proposed on the following streams and ditches: Kauai: Wainiha (Upper Wainiha), Lumahai (Lumahai Hydro), Hanalei (Hanalei Hydro and the Upper Wailua Hydro), Wailua (Lower Wailua Hydro), and the Kokee Ditch (Kitano Hydro); Maui: East/West Wailuaiki Stream (East/West Wailuaiki Hydro); Hawaii: Wailuku River (Wailuku Hydro) and Honolii (Honolii Hydro). Some of these have received approval but have not been built, others are in various stages of permitting or the applications have been withdrawn.

Discussion

As a result of the 1981 study which indicated that the hydroelectric potential is low, and the costs relatively high, DBED has devoted little agency time to its further development. However, DBED believes that hydropower is an important renewable energy resource which can and should be developed in harmony with aquatic, riparian, cultural and recreational use of our streams. Whether this harmony can be achieved in Hawaii's small streams is a matter of considerable debate. The fact remains that presence of diversion for hydroelectric facilities is a significant modification to a stream and that if the proposed projects were all developed, Hawaii may have no large free flowing streams left.

Future Research

A statewide hydroelectric master plan is needed that balances river protection with hydroelectric power. CWRM, DBED, appropriate government agencies, environmental organizations and hydroelectric developers should all be involved in developing such a plan.

Sources

Published and Unpublished Documents

CDUA applications and Environmental Impact Statements for Kauai: Wainiha (Upper Wainiha), Lumahai (Lumahai Hydro), Hanalei (Hanalei Hydro and the Upper Wailua Hydro), Wailua (Lower Wailua Hydro), and the Kokee Ditch (Kitano Hydro). Maui: East/West Wailuaiki Stream (East/West Wailuaiki Hydro). Hawaii: Wailuku River (Wailuku Hydro) and Honolii (Honolii Hydro).

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Table 13 Hydroelectric Power

Active	Hydroelectric plant active in 1988	Source	Source of water used for hydro
Potential	Hydroelectric potential --DPED 1981	Hydro Name	Common reference name
Proposed	Proposed hydroelectric plant	Operator, survey or applicant	Operator, surveyed by DPED, or original applicant
Island	Island location	Cap. MW	Megawatt capacity
Code	HSA Stream Code	Ann. mm kWh	Annual output - million kilowatt hours

Island	Code	Source - Stream or Ditch	Hydro Name	Operator, survey or applicant	Cap. MW	Ann. mm kWh
			Active			
Kauai		Kekaha Ditch	Waiawa	Kekaha Sugar	0.48	1.80
		N. Wailua Ditch	LowerWaiahi	LihuePlantation	0.76	4.30
		N. Wailua Ditch	Upper Waiahi	LihuePlantation	0.46	3.10
	2-1-14	Wainiha	Wainiha Hydro	McBryde Sugar	3.60	30.00
		Alexander Res.	Kalaheo Pwrhse	McBryde Sugar	1.00	5.00
	2-4-04	Waimea	Mauka Pwrhse	Kekaha Sugar	1.00	5.60
	2-4-04.01	Makaweli	Olokele	Olokele Sugar	1.25	6.00
Maui		Wailoa Ditch	Paia Hydro	HC&S	1.00	3.00
		Wailoa Ditch	Hamakua	HC&S	0.50	2.20
		Wailoa Ditch	Kaheka	HC&S	4.50	19.00
	6-1-04	Kauaula	Kauaula Hydro	Pioneer Mill	0.30	0.90
Hawaii		Kohala Ditch	Hawi	Hawi Ag. Engineer.	0.20	1.50
		Hamakua Ditch	Haina	Hamakua Sugar	0.50	2.50
		Ainako	Wenco En.	Wenco Energy	0.01	0.10
	8-2-49	Kaieie	Hoowaiwai		0.05	0.20
	8-2-60	Wailuku	Waiau	HELCO	1.00	6.30
	8-2-60.01	Wainaku	Puueo	HELCO	2.25	12.80
	8-5-03.02	Waikaloa	Waimea	Hawaii County	0.02	0.10
			Potential			
Kauai		Kokee Ditch - Kitano		DPED	1.60	7.30
	2-1-14	Wainiha		DPED	3.70	17.40
	2-1-15	Lumahai		DPED	2.80	14.10
	2-1-19	Hanalei		DPED	2.55	11.46
	2-1-19	Hanalei-Hanalei Tunnel		DPED	1.40	8.20
	2-2-08	Wailua		DPED	11.70	25.20
Molokai		Molokai Tunnel-Kualapuu Res.		DPED	0.07	0.30
	4-1-09	Pelekunu		DPED	0.86	3.79
	4-1-21	Halawa		DPED	2.10	9.90

Island	Code	Source - Stream or Ditch	Hydro Name	Operator, survey orApplicant	Cap. MW	Ann. mm kWh
Maui		Wahiawa Res.		DPED	0.30	1.65
		Hoopoi Chute		DPED	1.00	3.00
		Honokohau Ditch		DPED	0.13	0.83
Maui	6-2-03	Kahakuloa		DPED	0.23	1.59
	6-2-07	Waihee		DPED	1.86	8.49
	6-3-15	Nailiilihaele		DPED	0.40	3.00
	6-4-03	Kolea		DPED	1.10	4.46
	6-4-15,16	E & W Wailuaiki		DPED	2.75	15.08
	6-4-22	Hanawi		DPED	1.00	5.03
Hawaii		Papaikou Mill		DPED	0.10	1.00
		Kohala Ditch - Union Mill		DPED	0.50	4.60
		Keaiwa-Meyer Reservoir		DPED	0.28	1.65
	8-1-16	Honokane Nui - East Branch		DPED	1.10	6.19
	8-1-16	Honokane Nui - Awini Falls		DPED	1.50	7.68
	8-1-44	Wailoa		DPED	1.85	10.29
	8-2-16	Pohakupuka		DPED	0.60	2.30
	8-2-39	Alia		DPED	0.33	1.54
	8-2-56	Honolii		DPED	3.90	17.57
	8-2-60	Wailuku		DPED	2.00	11.07
			Proposed			
Kauai	2-1-14	Wainiha	Upper Wainiha	McBryde Sugar	3.80	20.00
	2-1-15	Lumahai	Lumahai Hydro	Garratt Callahan	4.00	23.70
	2-1-19	Hanalei	Hanalei Hydro	Dominion	6.00	29.00
	2-2-08	Wailua	Wailua Hydro	Bonneville	6.60	17.50
	2-1-19	Hanalei	Upper Wailua	Bonneville	1.30	7.00
Maui	6-4-15,16	Wailuaiki	E&W Wailuaiki	Bonneville	2.70	7.90
Hawaii	8-2-56	Honolii	Honolii Hydro	Mauna Kea Power	14.60	35.00
	8-2-56	Honolii	Honolii Hydro	Island Power	4.80	20.40
	8-2-60	Wailuku	Wailuku Hydro	Garrett Callahan	5.00	17.70
	8-2-60	Wailuku	Wailuku Hydro	Kahala Energy	9.00	27.00

Channelization

Channelization in this study refers to the lining, partial lining or alteration of a stream course. Other channel alteration activities that can change the nature of a stream – dredging and maintenance, for example – were not inventoried.

Channelization is generally undertaken to increase land available for development. This action can reduce the likelihood of frequent or sizable flooding, drain lowland areas, limit or prevent erosion, and allow for roadcrossings or other construction over the stream course. The type of channelization used depends on the purpose, effectiveness, cost of construction and maintenance, availability of land or right of way, steepness of slope, soil conditions, and degree of concern for aquatic and riparian species, recreational opportunities, and aesthetics.

Seven types of channelization are inventoried in this study. Sources of information used to compile the data in this section include the 1978 Timbol and Maciolek channelization study, and permit files from the U.S. Army Corps of Engineers, DLNR Division of Water and Land Development, and county Departments of Public Works. The relatively large number of sources was necessary due to varying jurisdictions and periods of time that agencies and researchers collected information.

Over 19 percent of Hawaii's 376 perennial streams have been channelized to some degree, including most of those on Oahu. Approximately 34 have been lined with concrete or other material; one on Kauai, 26 on Oahu, four on Maui, and three on Hawaii.

Background

Streams can be a focal point of recreational or urban development, but they also create physical barriers, overflow their channels during storms, and occupy valuable property as they meander through the landscape. Channelization has been used as a partial solution to these problems. Indeed, it has become commonplace in Hawaii and elsewhere.

Channelization has had a major effect on the urban landscape since the first stream alterations in Hawaii in the early 1900s to huge concrete-lined channels today. It allows flood waters to be carried out to sea away from people and property; stabilizes stream banks to prevent meanders and resulting erosion of valuable property; facilitates road crossings; and can even increase the amount of developable land by confining waters underground and out of sight. These goals can and are being achieved by constructing extensive concrete lined channels and revetments with natural beds, installing culverts, or realigning the natural stream channel. Though there may be important benefits, there are also important costs. Problems include effects on marine, aquatic and riparian species, changes in recreational values, reduced groundwater recharge and a decrease in scenic qualities.

The Department of Health (1989) states that "channels constructed to facilitate the rapid transport and disposal of runoff from urbanized areas now discharge large volumes of storm water to the ocean. Much of this water would have normally seeped into the ground before channelization. Increases in the size and frequency of freshwater discharge events in Hawaii create imbalances in salinity and may limit coral growth or threaten long-term survival of coral reefs."

The City and County of Honolulu's Water Management Plan (1980) also suggests that channelization can be quite harmful to marine animals. "Studies have shown this method of storm water disposal to be harmful to environments near the channel discharges. Freshwater 'slugs (storm induced flous)' may cause severe degradation and even total destruction of saline sensitive biota."

Parrish et al. (1978) evaluated specific types of channelization from an aquatic resources perspective. They found that virtually every channelization project began by destroying some or all of the riparian vegetation and created short-term turbidity. Realigned channels suffer primarily from increased velocity, excessive illumination and warming due to the removal of shade producing vegetation. Replanting could mitigate these effects to some degree. Revetments have characteristics similar to realigned channels. However, the artificial banks may increase water temperature and alter habitat characteristics.

Lined channels present serious problems (Parrish et al. 1978). Habitat destroyed during construction never recovers. Lined channels that are built oversize to accommodate storm-induced freshet flows, usually have shallow water which provides very poor habitat for aquatic species. With the elimination of streamside vegetation and the conductivity of concrete/masonry substances, the shallow water heats up rapidly to temperatures lethal to some aquatic species. Mitigative measures such as low flow notches, periodic interruption of lined channels with natural channels, and shading can reduce some of the negative effects of lined channels.

The 1978 study also examined culverts and found that short, stream-level culverts did not have a significant effect on aquatic organisms. Extended culverts, however, appear to provide unsuitable habitat due to the lack of illumination.

Generally, Parrish et al. (1978) recommended that any channelization should "approximate the original channel length to retain natural water speed and avoid destructive erosion below the channelized sections."

Most types of channelization severely affect if not ruin the aesthetic qualities of a stream. Concrete lined channels are usually oversized to accommodate 10-, 30-, or 100-year floods. They are generally denuded of vegetation, and often enclosed in chain-link fences for public safety. "Present flood control design criteria in effect forces construction of a lined channel or oversized concrete ditch" (Nuuanu Plan, 1974). The Honolulu Building Code states that "every effort should be made to minimize flood potential and to protect the lives and property of the inhabitants of the City and County of Honolulu." It further states that "the owner shall dedicate and the city shall accept the land or any interest in the land necessary for the drainage facilities." In addition, "42 inch fences may be required depending on the height of the wall or bank, shape of the channel, or the location of the channel improvement and/or the possibility of people injuring themselves because of the channel improvement" (City and County of Honolulu, 1988).

Channelized streams have very little recreational value. Small urban streams that probably once served as playgrounds for children are now concrete lined and fenced drainageways. Large "canals," such as Oahu's Ala Wai and Kawainui, are boaters' havens. Some think that canals such as the Ala Wai actually enhance the aesthetic qualities of urban streams. Other channels that are frequently dry are illegally used for skateboarding.

Once a stream is channelized, both the extent of potential flooding and the restrictions on development are reduced. However, the City and County of Honolulu land use ordinance does allow for various types of construction in flood hazard districts. Development can co-exist with the natural stream characteristic flooding by elevating structures above the "regulatory flood elevation." This approach has been used throughout the tropics in the past.

Streams can also be valuable resources for urban design. "Adequate flood control can be provided without destroying the natural environment if aesthetic considerations are given top priority in design" (Nuuanu plan, 1974). "Flood control" can be accomplished through land use and development guidelines or through less destructive artificial types of channelization that incorporate mitigative measures and aesthetic considerations.

Methods

Inventory

Members of the Physical Characteristics Committee from DOWALD helped determine the content of this inventory, the data sources, and the process that would be used to gather that information. The committee decided to build upon the 1978 study prepared by Amadeo Timbol and John Maciolek. This decision determined the structure of the database.

Data on the type, length and last date of channelization were collected for each stream identified as altered. All of this information was tied to the data source. Permit numbers were also recorded when possible as references. Very short stream-level culverts are not included in this study.

Channelization Types

Lined: An artificial channel, usually lined with concrete. It can have either a flat bottom or a modified "V"-shaped bottom. There is no natural bed. Streams with lined channels are noted in Table 7.

Lined with low flow notch: This is a lined channel with a notch in the bottom to collect the lowest flow.

Realigned: The stream is realigned and the original riparian vegetation generally removed.

Culvert: Cylindrical drainage conduit.

Elevated Culvert - Used to carry streams under highways. Culverts are elevated such that a waterfall is created on the downstream end.

Extended Culvert - A long culvert that is usually found in residential areas.

Revetment: One or both banks are reinforced or replaced but the channel bed remains natural.

Drainageway: Conduit in a waterway that is backfilled and used for other than a vehicular crossing. It is not a culvert.

Length

The length of the channelization was recorded when possible but the information was not consistent nor recorded using the same scales. Timbol and Maciolek estimated the length of the channelization in kilometers from the Real Estate Atlas. Length of projects identified through the COE permit files varied by applicant. Usually some size figure was provided but occasionally it was the cubic yardage of fill material. DOWALD provided HSA with all information regarding channelization projects regulated by their Stream Channel Alteration Permits (SCAP). County public works departments generally reported length in feet.

Date

The date a stream was last channelized was deemed important as a reference point and for database updating purposes. Timbol and Maciolek (1978) collected construction dates from government agencies. DOWALD and neighbor island public works departments provided dates from their records. City and County of Honolulu Public Works dates were obtained from reports, personnel and from blueprints stamped "As Built." COE dates were generally the date the permits were issued.

Permit Number

Permit numbers were provided for projects regulated by the COE or DOWALD. Neither county public works departments nor Timbol and Maciolek (1978) provided permit numbers.

Data Sources

Timbol and Maciolek: Timbol and Maciolek (1978) prepared a channelization inventory during the mid-1970s using field surveys and the 1975 Real Estate Atlas. Estimates of length in kilometers were made from the Real Estate Atlas whenever possible, while the construction dates were obtained from government agencies. All data from their report are included in this study. Their information represents the majority of channelization data prior to 1975.

Department Land and Natural Resources /Division of Water and Land Development: DLNR has been charged with regulating the activities in Windward Oahu's streams since 1984. The DLNR also regulates all streams statewide (except on federal lands) through its Stream Channel Alteration Permit (SCAP) process Since the passage of the State Water Code in 1987. SCAPs are required for actions that "alter stream channel, or the flow of water therein, by changing the shape of the channel, placing materials in or removing materials from a stream channel" (Department of Planning and Economic Development, 1986).

DOWALD staff provided HSA with a list of pending and completed stream alteration projects.

U. S. Army Corps of Engineers: The COE has jurisdiction over channelization up to the stream headwaters. Headwater is defined as uppermost point on a non-tidal stream where the average annual flow is five cubic feet per second. The COE also has jurisdiction over projects which "will cause the loss or significant adverse modification of more than one acre of waters of the United States" (including wetlands)(COE 1986).

The COE considers all factors relevant to the project including "conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production and, in general, the needs and welfare of the people" before it issues a permit (DLU 1986).

DOWALD, COE staff, and the HSA Study Team determined that a review of the COE General and Nationwide Permit indexes and files for channelization projects since 1976 would identify the type, extent and location of recent projects.

County Public Works: HSA asked County Public Works Departments on each island to provide a list of channelization projects that they were involved with between the years of 1976 and 1986 or more recent projects that had been done independent of either DOWALD or COE. This proved to be a manageable task for all counties except Honolulu. Information regarding channelization in Honolulu County was collected from knowledgeable Public Works engineers, flood control reports, and subdivision maps.

Results

More than 70 streams have been channelized statewide (Table 7). Most of the channelized streams are on Oahu and therefore only that island is mapped (Map 3). A total of at least 100 miles of perennial streams have been altered through channelization.

Discussion

Streams that conflict with land ownership or land development plans often are channelized. Stream channel alteration increases with urbanization pressure. The rate of channelization has not decreased since the 1978 channelization study, which revealed the negative impacts of channelization on natural resources. Since the report, several miles of Iao stream were lined with a low flow notch at the bottom to improve the habitat for aquatic species. However, a significant number of straightlined channels, those most destructive to aquatic habitat, continue to be constructed to this day.

Clearly a variety of factors are considered from the time decision is made to do something about flood control to the actual construction. But, once the decision to channel the stream is made, the design is left primarily to an engineer. A mechanism is needed whereby the enhancement of the habitat of aquatic organisms and aesthetics are factored into the design decision before the project reaches the Commission on Water Resource Management for final decision.

Limitations

Government agencies on federal, state and county levels are all involved in the channelization permit process. For some major projects, permits from all three agencies might be necessary, whereas for other projects, only one agency permit may be required. Information therefore, has had to be obtained from six different governmental agencies for channelization activity since 1977. This use of multiple sources has resulted in some duplication, inconsistancies and gaps of information. However, the number of sources has increased the reliability of the data.

HSA has relied primarily on Timbol and Maciolek (1978) for channelization information prior to 1977. Each agency source has a unique set of information based on different permitting times and jurisdictions for data after 1977. The information presented here may not include:

- smaller channelization projects between 1976 and 1977;
- channelization projects on streams with less than 5 cfs between 1976 and 1984-86;
- channelization projects on streams with less than 5 cfs on federal lands;
- smaller scale development (subdivision developments) on neighbor islands prior to 1977 missed through field surveys (because Timbol and Maciolek only consulted the Real Estate Atlas for Oahu);
- channelization within subdivision developments on Oahu between 1977 and 1987; and
- channelization project initiated in 1990 or later.

Channelization length is not measured consistently by the data sources. Some use kilometers, some feet, some cubic yards of fill. Others have added the total length of stream bank revetted rather than the length of the stream affected. However, in an attempt to get a composite picture of channelization in the state, we have combined this information. Most channelization measurements prior to 1976 are in kilometers; subsequent measurements are generally in feet. Since it is inappropriate to convert all of the information to the small-scale measurement "feet", we have chosen to convert to miles, another common measurement. This figure must be used with extreme caution.

Future Research

One need identified by DOWALD staff was to locate all channelization. This was determined to be important information that would be best illustrated on a map or GIS. This inventory does not identify all channelization developments in the state. Various projects that are part of subdivision developments gain approval at the county level. Therefore a thorough review of subdivision blueprints at each county department of public works would result in a more comprehensive inventory.

It would be very helpful for future inventories if every channelization project was required to list the length of altered stream as part of the application.

Channelization has become the usual solution for construction and development projects faced with stream-related issues. The impacts on aesthetic and natural resources in particular are increasingly apparent. Alternative solutions for flood control, flood avoidance, and living with floods are needed before all streams become channelized in some part of their reach. Mitigative and restoration techniques could be explored for streams already channelized.

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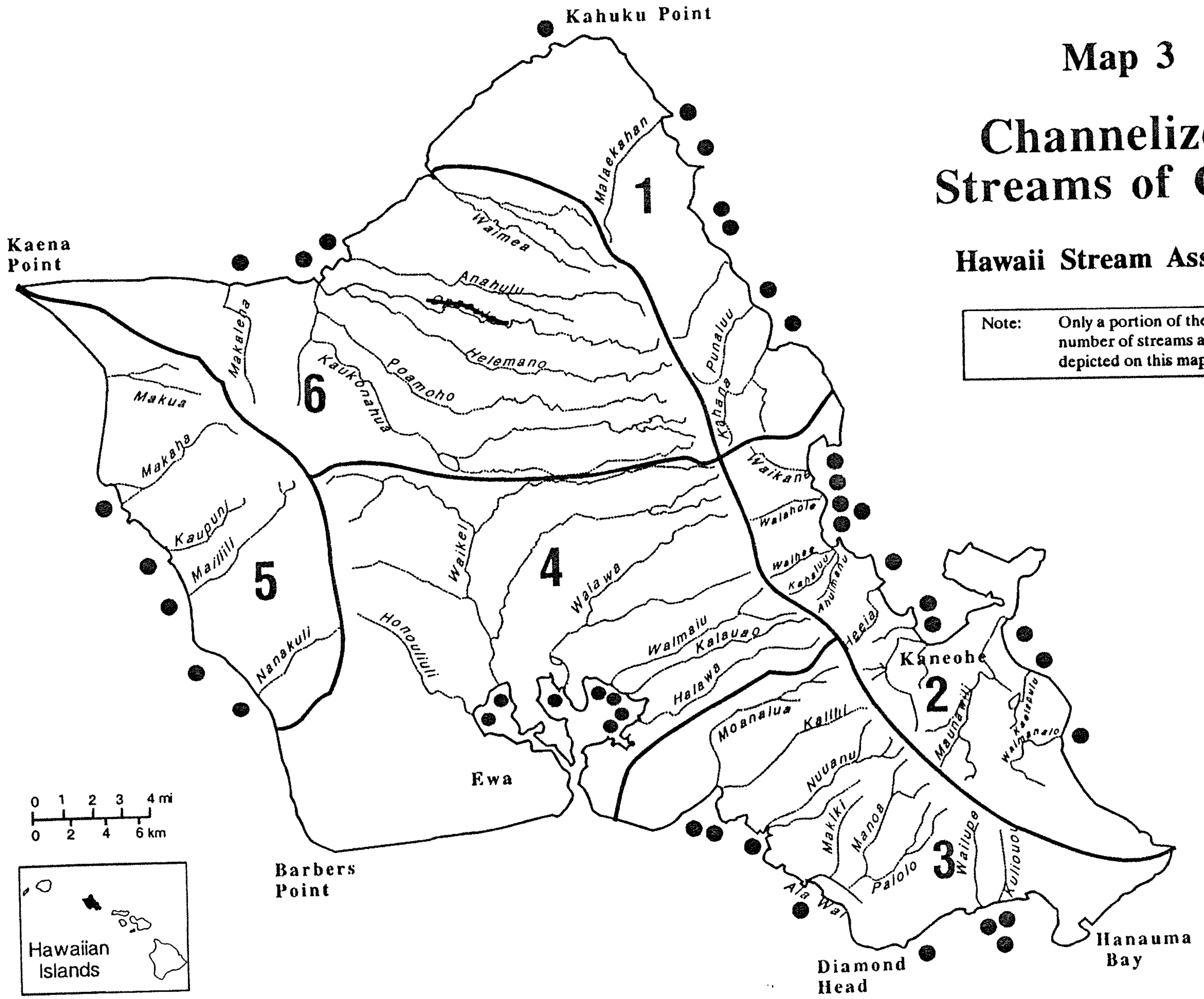
Map 3

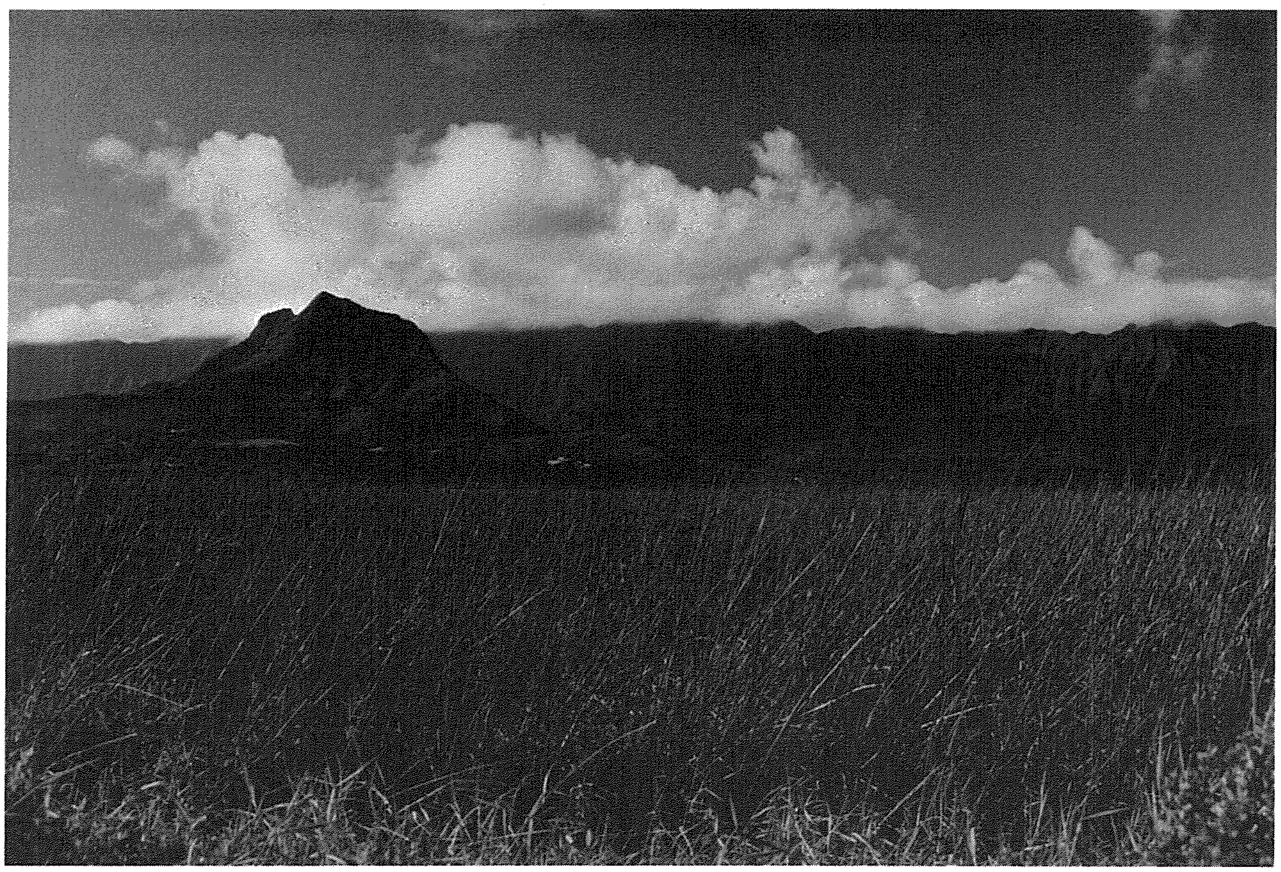
Channelized Streams of Oahu

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.



Special Areas



Special Areas

Special areas are locales which have been identified by federal, state, county or private agencies as having natural or cultural resources of particular value. These sites were identified because they were stream-associated, close to streams or because they encompass a stream or part of a stream. They may or may not have been established for their stream resources. They include estuaries, embayments, wetlands, recovery habitats, natural area reserves, wildlife refuges and sanctuaries, private preserves, national natural landmarks, historic sites, and research and educational sites, parks, and waterfalls. Forest reserves, possibly the most important statewide special area, are not included in this inventory because they are so widespread.

This chapter outlines the various types of special areas and their associated streams. The presence of these can serve as a flag for review when any development project is proposed in the vicinity, even if it is beyond the boundaries of a special area. Table 16 is a summary checklist.

Methods and Results

A variety of different elements comprise this Special Areas section. Each element is defined, the methods and sources documented and the general results noted. The categories used here and in Table 16 reflect the general nature of the information.

Designations

Nationwide Rivers Inventory

The National Park Service, in the early 1980s, identified rivers across the United States eligible for Wild and Scenic River status. Generally these rivers were identified as having outstanding natural, cultural and recreational characteristics, and were free-flowing and relatively undeveloped. Eighteen Hawaiian streams and tributaries received this recognition.

Kauai

2-4-04s	Waimea tributaries Waialae and Koaie
2-1-15	Lumahai
2-5-16	Nualolo
2-1-19	Hanalei
2-1-10	Hanakapiai
2-1-04	Kalalau

Molokai

4-1-21	Halawa
4-1-19	Kawainui
4-1-15	Wailau

Maui

6-4-22	Hanawi
6-2-03	Kahakuloa
6-5-13	Oheo and tributaries Palikea and Pipiwai

Hawaii

8-2-33	Kolekole
8-2-60	Wailuku
8-1-35	Waimanu

Priority Aquatic Sites

Dr. George Fenwick, TNC's National Project Director for Aquatic Ecosystems, identified "Priority Aquatic Sites for Biodiversity Conservation" nationwide. This list included sites meeting one or more of the following criteria:

- Best intact remnants of damaged or declining systems;
- Best opportunities for protection of representative viable examples of major regional systems;
- Sites of endangered species;
- Sites of endangered communities.

Kauai

2-1-15	Lumahai
2-4-04s	Waimea
2-1-14	Wainiha

Molokai

4-1-09	Pelekunu

Maui

6-5-11,12	Puaaluu-Hahalawe
6-4-04	Waikamoi
6-4-22	Hanawi
6-4-09	Honomanu-Keanae

High Quality Streams

USFWS developed a statewide "List of High Quality Streams" in 1988 for DLNR, using the following criteria;

- High habitat value for native, migratory stream animals
- Presence of candidate endangered species *Lentipes concolor*;
- Presence of riparian wetlands of value to migratory birds and endangered Hawaiian waterbirds;
- Recognition on the Hawaii Component list of the NPS's Nationwide Rivers Inventory;
- Streams in National Parks or Wildlife Refuges, State Wilderness Areas, Natural Area Reserves, and private nature preserves;
- Streams that are the subject of ongoing scientific research projects.

More than 80 Hawaiian streams were identified as High Quality. These are listed in the database.

National Natural Landmarks and proposed NNL

National Natural Landmarks are established "to protect the best examples of physical and natural landmarks for this and future generations." NNL and proposed NNL were identified by the National Park Service Cooperative Park Research Unit.

National Natural Landmarks

Molokai Cliffs

4-1-09 Pelekunu
4-1-10 Waipu
4-1-11 Haloku
4-1-12 Oloupena
4-1-13 Puukaoku
4-1-14 Waiele
4-1-15 Wailau

Iao Valley

6-2-09 Iao

Proposed National Natural Landmarks

Mixed Lowland Forest

2-1-08 Waiahuakua

Eragrostis Grasslands

6-1-03 Laniupoku

Montane Bogs

6-1-05 Kahoma
6-1-07 Honokowai
6-1-11 Honokohau

Pandanus Forest

6-4-32 Kawakoe tributary Mokulehua
6-4-33 Honomaele

Marine

Marine Life Conservation Districts/Fishery Management Areas

Marine Life Conservation Districts are established by DLNR to protect, conserve, and propagate marine life by prohibiting or limiting consumptive uses of the marine resources. Honolua Stream on Maui is the only stream-associated MLCD.

Fishery management areas were established by DLNR to enhance and improve near-shore recreational fishing by restricting certain types of fishing activities within the high water marked boundaries of the area. Three stream-associated FMAs were identified on Oahu: Waialua Stream, Ala Wai Canal, and Kapalama Canal.

National Estuarine Research Reserve

Research Reserves serve as field laboratories managed for long-term environmental monitoring and scientific research on estuaries. While NOAA is responsible for designating and administering the NERR Program, management of the Reserve is left up to the state. In Hawaii, the program was established as part of the Coastal Zone Management Act of 1972 and is administered by the Natural Area Reserve System. There is only one NERR in Hawaii, at Waimanu, Hawaii, which encompasses eight streams.

Estuaries and Embayments

Estuaries and embayments provide important habitat for terrestrial, marine and aquatic species. Their importance to the life cycle of various species is not fully understood, but they may be critical to the survival of some species. The distinction between an estuary and an embayment is not always precise. Sometimes the definition depends on one's perspective, be it scientific or jurisdictional.

Estuaries

Estuaries are defined by the DOH as "deep, characteristically brackish coastal waters in well defined basins with a continuous or seasonal surface connection to the ocean that allows entry of marine fauna. Estuaries may be either natural, occurring mainly at stream or river mouths; or developed, artificially, or strongly modified from the natural state such as dredged and revetted stream termini" (HAR, Chapter 11-54).

Estuaries were identified by two sources: John Ford, USFWS; and the Estuarine Sanctuary Site Selection Program, developed by DPED's Coastal Zone Management Program with the National Oceanic and Atmospheric Administration (NOAA).

"Tentative List of Estuaries in the Hawaiian Islands," prepared by Ford, was based on the Department of Health definition stated above. It represents his professional opinion based on his personal knowledge with reference to USGS quadrangle maps and does not include quality judgments. He recommends field confirmation of these sites. More than 50 streams have associated estuaries by Ford's count (Table 14).

The DPED/NOAA estuary list was prepared as part of the National Estuarine Sanctuary Program Site Evaluation. The database includes and distinguishes between those estuaries inventoried and those determined to be of high quality. These estuaries number around 15 and were coded to streams by HSA (Table 14).

Embayments

Embayments are described by the DOH as "land confined and physically protected marine waters with restricted openings to open coastal waters defined by the ratio of total bay volume to the cross-sectional entrance area of seven hundred to one or greater" (HAR, Chapter 11-54).

Embayments included in the database were identified from two sources: the State Department of Health and the Estuarine Sanctuary Site Selection Program.

The DOH classified the water quality of each embayment as AA or A. DOH recommends that Class AA embayments "remain in their natural pristine state as nearly as possible with an absolute minimum of pollution or alteration of water quality from any human-caused sources or actions. To the extent practicable, the wilderness character of these areas shall be protected." Class A waters are suggested for protection for recreational and aesthetic enjoyment. "Any other use shall be permitted as long as it is compatible with the protection and propagation of fish, shellfish and wildlife and with recreation in and on these waters." Embayments were associated with 41 streams flowing into them as indicated on USGS maps (Table 14).

The 1974 CZM/NOAA list was prepared as part of the National Estuarine Sanctuary Program Site Evaluation. The database includes both those embayments inventoried and those that received the highest score. Scores were based on the following criteria:

- Fits the definitions of an estuarine sanctuary;
- Would provide pertinent CZM input;
- Has potential for non-destructive multiple use;
- Conflicts least with existing uses, owners, and zoning;
- Is of documented scientific or public concern;
- Threats to current conditions are perceived;
- Has relevant research potential if preserved;
- Is in a relatively unaltered pristine condition;
- Ecological condition can be preserved through acquisition;
- Best land ownership conditions for state equity.

Embayments were associated with the streams that flow into them as shown on USGS maps (Table 14).

Historic

Historic Sites

The National Register of Historic Places lists sites that are associated with events or the lives of significant persons, embody distinctive characteristics, historic or prehistoric information or cultural significance. These sites are given special designation but little protection. The State Register of Historic Places also lists historic sites. Stream related historic sites included on the national and state lists were included in the database.

Table 14 Estuaries and Embayments

Estuary
/ Identified by John Ford or CZM
+ High Quality by CZM

Embayment
/ Identified by CZM
+ Identified as high quality by CZM
A DOH Water Quality Classification
AA DOH Water Quality Classification

CODE	NAME	ESTUARY	EMBAYMENT
2-1-14	Wainiha R	/	
2-1-15	Lumahai R	/	+
2-1-16	Waikoko		+,AA
2-1-17	Waipa		+,AA
2-1-18	Waioli	/	+,AA
2-1-19	Hanalei R.	+	+,AA
2-1-20	Waileia		+,AA
2-1-25	Kalihiwai R.	/	
2-1-28	Kilauea	/	/
2-2-01	Anahola	/	
2-2-04	Kapaa	/	
2-2-06	Waikaea Canal	/	
2-2-08s	Wailua R. System	/	
2-2-12	Hanamaulu	/	A
2-2-13	Nawiliwili		A
2-2-14	Puali		
2-2-15	Huleia	/	A
2-3-06	Wahiawa		A
2-3-07	Hanapepe	/	A
2-4-04s	Waimea R. System	/	/
3-1-13	Kaluanui	/	
3-1-16	Punaluu	/	
3-1-18	Kahana	+	+,AA
3-2-07s	Kahaluu R. System	/	
3-2-08	Heeia		AA
3-2-09	Keaahala		AA
3-2-10	Kaneohe		AA
3-2-11	Kawa	/	AA
3-2-13	Kawainui/Maunawili	/	
3-2-15	Waimanalo	/	/
3-3-03	Kuliouou	/	
3-3-07s	Ala Wai C. System	/	A
3-3-09	Nuuanu	/	A
3-3-10	Kapalama	/	A
3-3-11	Kalihi	/	A
3-3-12	Moanalua	/	A
3-4-02	Halawa	/	A
3-4-03	Aiea	/	A
3-4-04	Kalauao	/	A
3-4-05	Waimalu	/	A
3-4-06	Waiawa	/	A
3-4-10	Waikele	/	A
3-4-11	Honouliuli	/	A
3-5-05	Kaupuni		A
3-6-06s	Kiikii System	/	A
3-6-07s	Paukauila System	/	A
3-6-08s	Anahulu System	/	AA
4-1-09	Pelekunu	/	
4-1-15	Wailau	/	
4-1-21	Halawa	+	+
6-1-05	Kahoma		A
6-1-10	Honolua	+	+
6-2-10	Waikapu	/	
6-4-01	Oopuola	/	
6-4-09	Honomanu	/	
8-1-15	Pololu	/	/
8-1-35	Waimanu	+	+
8-1-44	Wailoa/Waipio	+	+
8-2-32	Hakalau	/	
8-2-33	Kolekole	/	
8-2-43	Kawainui	/	
8-2-56	Honolii	/	
8-2-59	Pukihae		A
8-2-60	Wailuku R.	/	A
8-2-61	Wailoa R.	/	A

Habitat

Natural Area Reserve System

The Natural Area Reserve System was established by DLNR "to preserve and protect in perpetuity, unique and representative samples of [the state's] remaining natural environment." These environments encompass bogs, grasslands, marine coastal reefs, forests, lava flows, coastal dunes and ice-age terrain. NARS maps were used to associate the protected areas with streams.

Hono O Na Pali NAR		
	2-1-07	Hanakoa
	2-1-08	Waiahuakua
	2-1-09	Honolulu
	2-1-10	Hanakapiai
Kuia NAR		
	2-5-16	Nualolo
Mount Kaala NAR		
	3-6-06s	Kiiki System, Kaukonahua (3-6-06.02)
	3-6-04	Makaleha
	3-6-07	Paukauila
Puu Alii NAR		
	4-1-03	Waikolu
	4-1-04	Wainene
	4-1-05	Anapuhi
	4-1-06	Waiohookalo
Olokui NAR		
	4-1-10	Waipu
	4-1-11	Halekou
	4-1-12	Oloupena
	4-1-13	Puukaoku
	4-1-14	Wailele
West Maui NAR--Kahakuloa Section		
	6-2-02	Honanana
	6-2-03	Kahakuloa
	6-2-06	Makamakaole
	6-2-01	Poelua
West Maui NAR--Panaewa Section		
	6-1-05	Kahoma tributaries
	6-1-05.01	Halona and Kanaha
West Maui NAR--Honokowai Section		
	6-1-07	Honokowai tributary Amau
Hanawi NAR		
	6-4-17	Kopiliula
	6-4-21	Kapaula
	6-4-22	Hanawi
	6-4-23	Makapipi
	6-4-24	Kuhiwa
	6-4-31	Heleleikeoha
Puu O Umi NAR		
	8-1-16	Honokane Nui

8-1-33	Kaimu
8-1-34	Pae
8-1-35	Waimanu
8-1-44	Wailoa tributaries Kawainui and Kawaiki
8-1-42	Waipahoehoe
8-5-03.01	Waikoloa tributary Kohakohau

Lapahoehoe NAR

8-2-05	Kilau
8-2-09	Kaiwilahilahi
8-2-10	Haakoa
8-2-11	Pahale

Plant Sanctuary

Plant sanctuaries are small areas (usually fewer than 50 acres) set aside to preserve remnant populations of rare native plant species. The State Division of Forestry and Wildlife (Dr. Carolyn Corn) informed HSA that at present there are no stream-related plant sanctuaries.

Waterbird Recovery Habitat

These habitats were identified by USFWS as locations that, if protected, would help foster the recovery of threatened and endangered species of birds. This listing protects the areas from projects involving state and federal dollars but provides no protection from private developers. Management recommendations such as acquisition, cooperation with landowners, and cooperative agreements are also noted. Recovery habitats were associated with over 40 streams by the USFWS (John Enbring and Andy Yuen).

Private Preserves

Nature Conservancy of Hawaii manages land in Hawaii for the purpose of protecting unique natural environments and rare and endangered species of plants and animals. Nature Conservancy Preserves were associated with streams by the HSA with the assistance of TNCH (Audrey Newman).

Pelekunu Preserve-TNCH

4-1-04	Wainene
4-1-05	Anapuhi
4-1-06	Waiohookalo
4-1-07	Keawanui
4-1-08	Kailiili
4-1-09	Pelekunu

Puu Kukui Watershed Management Area-TNCH

6-1-08	Kahana
6-1-09	Honokahua
6-1-10	Honolua
6-1-11	Honokohau

Waikamoi Preserve-TNCH

6-4-04	Waikamoi
6-4-06	Puohokamoa
6-4-07	Haipuaena

6-4-09	Honomanu
6-4-10	Nuaailua
6-4-11	Piinaau
6-4-14	Wailuanui
6-4-15	W. Wailuaiki
6-4-16	E. Wailuaiki
6-4-17	Kopiliula

Wildlife Refuges

Wildlife refuges are established by the USFWS to provide important habitat for wildlife. These refuges were tied to streams by HSA with the assistance of the USFWS (John Ford).

2-1-19	Hanalei R.
2-2-15	Huleia
3-4-11	Honouliuli
8-2-30	Umauma
8-2-32	Hakalau
8-2-33	Kolekole
8-2-53	Kapue
8-2-56	Honolii
8-2-60	Wailuku R.

Wildlife Sanctuary

Wildlife sanctuaries are established for "the conservation, management, and protection of indigenous wildlife" (HRS 13-125-3). Sanctuary maps were reviewed to tie Paiko Wildlife Sanctuary to Kuliouou Stream on Oahu.

Parks

National Parks

National Parks are established "to preserve physical, natural, and cultural resources for the enjoyment of this and future generations." The four perennial streams that flow through National Parks in Hawaii were identified on USGS quad maps, and included in the database.

Kalaupapa National Historic Park

4-1-01	Waihanau
4-1-02	Waialeia
4-1-03	Waikolu

Haleakala National Park

6-5-13	Oheo

State Parks

State Parks are established "to make available examples of Hawaii's natural, cultural, and scenic treasures. Attempts are made to interpret the natural and cultural areas to develop a keener public awareness, appreciation and understanding of [Hawaii's] rich legacy. The exceptional scenic areas are managed for their aesthetic and inspirational values while vantage points are developed for their superb views of [Hawaii's] landscape." Hawaii's state parks range from highly landscaped areas to wilderness.

2-1-03	Nakeikionaiwi
2-1-04	Kalalau
2-1-05	Pohakuao
2-1-06	Waiolaa
2-1-07	Hanakoa
2-1-08	Waiahuakua
2-1-09	Hoolulu
2-1-10	Hanakapiai
2-1-11	Maunapuluo
2-2-08s	Wailua R. System
2-4-04s	Waimea R. System
3-1-18	Kahana

County Parks

County Parks are established for recreational use. Restrooms, drinking water, showers and pavilions are often provided.

2-1-13	Manoa
2-1-19	Hanalei
2-2-06	Waikaea Canal
2-2-14	Puali
3-3-11	Kalihi
4-1-21	Halawa
8-1-13	Niulii
8-2-24	Waikaumalo
8-2-33	Kolekole

Research and Education

Agriculture, Aquatic and Aquaculture Research Sites

The inventory of research sites with existing or proposed facilities include UH Agricultural Experiment Stations, TNCH's proposed aquatic research site and UH aquaculture research sites and taro research. Stream related taro research takes place near the Limahuli (2-1-12), Hanalei (2-1-19), Wailua (2-2-08s), Manoa (3-3-07s) and Kaupuni (3-5-05). Other sites include aquaculture research at Hakipuu (3-2-01), and proposed aquatic research at Pelekunu (4-1-09)

Nature Study Areas

Nature Study Areas include established educational facilities or published guides to streams, botanical gardens and arboretums. Most of these sites were identified by the HSA Recreation Committee. The Bishop Museum's Ohia Project proposed program sites will also be included in this category upon completion.

2-1-12	Limahuli
2-1-19	Hanalei R.
2-2-13	Nawiliwili
2-3-04	Lawai

3-1-18	Kahana
3-2-05	Kaalaea
3-2-10	Kaneohe
3-3-07.01	Manoa
3-3-09	Nuuanu
3-3-10	Kapalama
3-3-12	Moanalua
3-5-05	Kaupuni
3-6-10	Waimea R.
6-2-09	Iao
6-2-10	Waikapu
6-3-01	Maliko
6-4-11	Piinaau
6-4-33	Ulaino
8-2-46	Hanawi

NASQAN
Comprehensive water quality data are collected at six USGS NASQAN sites. These are the Waimea River, Kauai; Waikele Stream, Oahu; Kalihi Stream, Oahu; Halawa Stream, Molokai; Kahakuloa Stream, Maui; and Wailuku River, Hawaii. See Water Quality Chapter.

Benchmark
USGS maintains one monitoring station in Hawaii for long-term National monitoring of water quality and other hydrologic information. This benchmark station is on the Honolii on Hawaii.

Wetlands

Wetlands serve as reservoirs for storm-water, groundwater recharge areas, filters for water-borne pollutants before they reach groundwater and/or inshore waters, habitat for waterbirds, and open space.

There are several definitions of wetlands. However, the term generally includes streams and refers to areas where:

- the soil is covered or saturated with water (ground or surface) continuously or at some time of the year;
- the substrate is primarily characterized by undrained moist or saturated soils; and
- the land supports water-loving plants (SRFP, February 1988).

The HSA database contains information from three different sources: the University of Hawaii Environmental Center Wetland Database (1990), Elliott and Hall (1977), and USFWS (1978). Each inventory lists a somewhat different type of wetland.

The U.H. Environmental Center (UHEC) Wetland Database contains information on wetlands fed by groundwater. These sites were identified by John Mink and Steven Lau of the U.H. Water Resources Research Center. The UHEC database is currently limited to sites identified on Oahu and Maui. The Environmental Center searched its database for 26 stream-associated wetlands and provided HSA with this information.

Geographers Marge Elliott and Erin Hall define wetlands as land areas "where water (fresh, saline or brackish) is the major factor controlling the development of soils and the development of the vegetative cover, if present." All wetland maps and descriptions included in their publication "Wetlands and Wetland Plants in Hawaii" were reviewed for reference or proximity to streams. Those 19 that appeared to be stream-associated were entered into the HSA database.

USFWS previously classified a wetland as an area having one of the following conditions:

- open standing water,
- the presence of hydrophytic vegetation (plants that grow in saturated conditions); or
- presence of hydric soils.

From that general definition it separates wetlands into five types: Marine; Estuarine; Riverine; Lacustrine; and Palustrine. The USFWS (Andy Yuen) determined that Palustrine wetlands (89 percent of Hawaii's wetlands) were stream-related resource systems and recommended that HSA include them in the inventory. This type of wetland is associated with inland marshes, bogs and swamps. The size varies greatly. All Palustrine wetlands indicated on the 1978 USFWS wetland maps were included in the database. More than 200 streams have associated Palustrine wetlands.

Waterfalls

The list of waterfalls was taken from the 1990 draft of National Landmarks of the Hawaiian Islands. This paper cites the Atlas of Hawaii as its source for waterfalls and notes that it is not exhaustive. The criteria used for the Atlas of Hawaii list of "Major Named Waterfalls" is: largest named waterfall on each major island, either in height or average discharge; all other named falls 250 feet or higher; and well-known smaller falls. Waterfalls noted in the index of Bier's reference maps of Hawaii were also included. Table 15 lists waterfalls from both sources.

Discussion

Impacts on special areas may occur as a result of actions far beyond the boundaries. It has become apparent that stream flows may be affected by distant tunnels and wells, aquatic species are affected by channelization, and watershed erosion and urban runoff end up downstream. Developments and other management decisions should be reviewed for their impact on these areas.

This is a fairly complete list of stream-associated special areas. It should serve as a preliminary checklist against which impacts of proposed developments should be measured. However, this list may not be inclusive of all of the special areas throughout the state and a more thorough search for special areas associated with proposed developments may be warranted.

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Table 15 Hawaii's Waterfalls

(Best known falls are boldfaced)

Kauai

Hanakoa Falls (Hanakoa 2-1-07)
Hinalele Falls (Wainiha 2-1-14)
Puwainui Falls (Wainiha 2-1-14)
Keanaawi Falls (Hanalei 2-1-19)
Hoopouli Falls (Anini 2-1-21)
Waihunehune Falls (Kalihiwai 2-1-25)
Kilauea Falls (Kilauea 2-1-28)
Waianuenue Falls (Wailua System 2-2-08s)
Kapakanui Falls (Wailua System. 2-2-08s)
Wailua Falls (Wailua System 2-2-08s)
Mana Waipuna Falls (Wailua System 2-2-08s)
Koholalele Falls (Wailua System 2-2-08s)
Opaekaa Falls (Wailua System 2-2-08s)
Halii Falls (Wailua System 2-2-08s)
Uhauiole Falls (Wailua System 2-2-08s)
Kapakaiki Falls (Wailua System 2-2-08s)
Ooiki Falls (Hanapepe 2-3-07)
Kahili Falls (Hanapepe 2-3-07)
Waipoo Falls (Waimea System 2-4-04s)
Mohihi Falls (Waimea System 2-4-04s)
Hihinui Falls (Waimea System 2-4-04s)
Oopulele Falls (Waimea System 2-4-04s)
Awini Falls (Waimea System 2-4-04s)
Moeloa Falls (Waimea System 2-4-04s)
Waialae Falls (Waimea System 2-4-04s)
Waikaka Falls (Waimea System 2-2-04s)

Oahu

Sacred Falls (Kaluanui 3-1-13)
Manoa Falls (Ala Wai System 3-3-07s)
Kahuawai Falls (Nuuanu 3-3-09)
Waipuhia (Nuuanu 3-3-09) (upside down falls)
Waihee (a.k.a. Waimea) Falls (Waimea 3-6-10)

Molokai

Haloku Falls (Haloku 4-1-11)
Oloupena Falls (Oloupena 4-1-12)
Wailele Falls (Wailele 4-1-14)
Kahiwa Falls (Kahiwa 4-1-18)
Hipuapua Falls (Halawa 4-1-21)
Moaula Falls (Halawa 4-1-21)
Mooloa Falls (Kamalo 4-2-14)
Haha Falls (Kamalo 4-2-14)
Hina Falls (Kamalo 4-2-14)

Maui

Honokohau (Honokohau 6-1-11)
Waiohiwi Falls (Maliko 6-3-01)
Twin Falls (Honopou 6-3-08)
Puohokamoa (Puohokamoa 6-4-06)
Haipuaena Falls (Haiuaena 6-4-07)
Waiokilo Falls (Waikamilo 6-4-13)
Waikani Falls (Wailuanui 6-4-14?)
Kopiliula Falls (Kopiliula 6-4-17)
Wailua Falls (Wailua 6-5-07)
Waihiumalu Falls (Wailua 6-5-07?)
Kekuapoowai Falls (Wailua 6-5-07)
Kanahuali'i Falls (Honolewa 6-5-08)
Waimoku Falls (Palikea/Oheo 6-5-13)
"Seven Sacred Pools" (Palikea/Oheo 6-5-13)
Kipahulu Falls (Koukouai 6-5-15)

Hawaii

Waiilikahi Falls (Waimanu 8-1-35)
Kaluahine Falls (Wailoa (8-1-44)
Honokane Nui (Kohala Ditch to Anini Ditch)
Hiilawi Falls (Lalakea 8-1-45)
Hikiau Falls (Kupapaulua 8-1-88)
Kahuna Falls (Kaahakini 8-2-62)
Akaka Falls (Kolekole 8-2-33)
Waiemi Falls (Hanawi 8-2-46)
Waialae Falls (Honolii 8-2-56)
Wahiloa Falls (Wailuku 8-2-60)
Hawaii Falls (Wailuku 8-2-60)
Rainbow Falls (Wailuku 8-2-60)
Kaimukanaka Falls (Wailuku 8-2-60)
Waiale Falls (Wailuku 8-2-60)
Peepee Falls (Wailuku 8-2-60)
Naalapa Falls (Wailoa 8-2-61)

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Table 16 Special Areas

CODE HSA code; island-hydrographic unit-stream (system)

NAME Stream name at mouth

"Y" - one or more special areas are known to be present within the category type.

PRK National, State and County Parks

HAB Natural Area Reserve System, plant sanctuary, Recovery Habitat for Water-birds, private preserves, Wildlife Refuges, Wildlife Sanctuary

MAR Marine Life Conservation Districts/ Fishery Management Areas, estuary, em-bayment.

WET Wetlands

DES National Rivers Inventory, Priority Aquatic Sites, High Quality Streams, National Natural Landmark Designations.

ED Agriculture, aquatic and aquaculture education or research sites, nature study areas, NASQAN, Benchmark.

HIS Historic Sites

WF Waterfalls

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
Kauai									
2-1-01	Awaawapuhi					Y			
2-1-02	Honopu					Y			
2-1-03	Nakeikionaiwi	Y							
2-1-04	Kalalau	Y			Y	Y			
2-1-05	Pohakuao	Y				Y			
2-1-06	Waiolaa	Y							
2-1-07	Hanakoa	Y	Y			Y			Y
2-1-08	Waiahuakua	Y	Y			Y			
2-1-09	Hoolulu	Y	Y						
2-1-10	Hanakapiai	Y	Y		Y	Y			
2-1-11	Maunapuluo	Y				Y			
2-1-12	Limahuli				Y		Y		
2-1-13	Manoa	Y				Y			
2-1-14	Wainiha R.			Y	Y	Y			Y
2-1-15	Lumahai R.		Y	Y	Y	Y			
2-1-16	Waikoko			Y					
2-1-17	Waipa		Y	Y	Y	Y		Y	
2-1-18	Waioli			Y	Y	Y		Y	
2-1-19	Hanalei R.		Y	Y	Y	Y	Y	Y	Y
2-1-20	Waileia		Y	Y	Y				
2-1-21	Anini								Y
2-1-25	Kalihiwai R.			Y	Y	Y			Y
2-1-26	Puukumu				Y			Y	
2-1-27	Unnamed								
2-1-28	Kilauea			Y	Y	Y			Y
2-1-29	Kulihaili								
2-1-30	E. Waiakalua				Y				

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
2-1-31	Pilaa								
2-1-32	W. Waipake								
2-1-33	E. Waipake								
2-1-34	Moloaa				Y			Y	
2-1-35	Papaa				Y				
2-1-36	Aliomanu				Y				
2-2-01	Anahola			Y	Y				
2-2-02	Kumukumu								
2-2-04	Kapaa			Y	Y	Y			
2-2-05	Moikeha Canal				Y				
2-2-06	Waikaea Canal	Y		Y	Y				
2-2-08s	Wailua S.	Y	Y	Y	Y				Y
2-2-10	Kawailoa								
2-2-12	Hanamaulu			Y	Y			Y	
2-2-13	Nawiliwili			Y	Y		Y	Y	
2-2-14	Puali	Y		Y	Y				
2-2-15	Huleia		Y	Y	Y	Y		Y	
2-3-01	Kipu Kai				Y				
2-3-02	Waikomo		Y		Y			Y	
2-3-04	Lawai				Y		Y	Y	
2-3-06	Wahiawa			Y	Y			Y	
2-3-07	Hanapepe			Y	Y			Y	Y
2-4-01	Mahinauli				Y				
2-4-02	Aakukui				Y				
2-4-03	Waipao				Y				
2-4-04s	Waimea S.	Y		Y	Y	Y	Y	Y	Y
2-5-06	Kinekine Ditch		Y						
2-5-07	Kaawaloa		Y						
2-5-08	Nahomalu		Y						
2-5-09	Kaulaula				Y				
2-5-10	Haeleele				Y				
2-5-13	Kauhao								
2-5-15	Milolii					Y			
2-5-16	Nualolo		Y		Y	Y			
Oahu									
3-1-03	Paumalu				Y				
3-1-04	Kawela				Y				
3-1-05	Oio				Y				
3-1-06	Malaekahana				Y				
3-1-07	Kahawainui				Y			Y	
3-1-08	Wailele Gl.				Y			Y	
3-1-09	Koloa Gl.				Y			Y	

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
3-1-10	Kaipapau				Y				
3-1-11	Maakua								
3-1-13	Kaluanui			Y	Y	Y			Y
3-1-16	Punaluu			Y	Y				
3-1-18	Kahana	Y	Y	Y	Y	Y	Y		
3-1-19	Kaaawa				Y				
3-1-20	Makaua				Y				
3-1-21	Unnamed								
3-2-01	Hakipuu				Y		Y		
3-2-02	Waikane				Y				
3-2-03	Unnamed				Y				
3-2-04	Waiahole				Y				
3-2-05	Kaalaea						Y		
3-2-07s	Kahaluu S.			Y	Y				
3-2-08	Heeia		Y	Y	Y				
3-2-09	Keaahala			Y	Y			Y	
3-2-10	Kaneohe		Y	Y	Y		Y	Y	
3-2-11	Kawa			Y	Y			Y	
3-2-13	Kawainui/ Maunawili		Y	Y	Y				
3-2-14	Kaelepulu Canal		Y		Y				
3-2-15	Waimanalo		Y	Y	Y				
3-3-03	Kuliouou		Y	Y	Y				
3-3-04	Niu				Y				
3-3-05	Wailupe				Y			Y	
3-3-06	Waialaenui				Y				
3-3-07s	Ala Wai S.			Y	Y		Y	Y	Y
3-3-09	Nuuanu		Y	Y	Y		Y	Y	Y
3-3-10	Kapalama			Y			Y	Y	
3-3-11	Kalihi	Y		Y	Y		Y	Y	
3-3-12	Moanalua			Y					
3-4-02	Halawa			Y	Y				
3-4-03	Aiea			Y	Y				
3-4-04	Kalauao			Y	Y				
3-4-05	Waimalu			Y	Y			Y	
3-4-06	Waiawa			Y	Y				
3-4-10	Waikele		Y	Y	Y		Y		
3-4-11	Honouliuli		Y	Y	Y			Y	
3-5-01	Nanakuli				Y				
3-5-02	Ulehawa								
3-5-04	Mailiili				Y				
3-5-05	Kaupuni			Y	Y				
3-5-07	Makaha				Y			Y	
3-5-08	Makua				Y				
3-6-03	Unnamed				Y				

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
3-6-04	Makaleha		Y		Y				
3-6-06s	Kiikii S.		Y	Y	Y				
3-6-07s	Paukauila S.			Y	Y				
3-6-08s	Anahulu S.		Y	Y	Y				
3-6-09	Loko Ea		Y		Y			Y	
3-6-10	Waimea R.		Y		Y		Y	Y	Y
				Molokai					
4-1-01	Waihanau	Y			Y				
4-1-02	Waialeia	Y							
4-1-03	Waikolu	Y	Y						
4-1-04	Wainene		Y						
4-1-05	Anapuhi		Y						
4-1-06	Waiohookalo		Y						
4-1-07	Keawanui		Y						
4-1-08	Kailiili		Y						
4-1-09	Pelekunu		Y	Y	Y	Y			
4-1-10	Waipu		Y			Y			
4-1-11	Haloku		Y			Y			
4-1-12	Oloupena		Y			Y			Y
4-1-13	Puukaoku		Y			Y			
4-1-14	Wailele		Y			Y			Y
4-1-15	Wailau			Y	Y	Y			
4-1-17	Waiahookalo								
4-1-18	Kahiwa								Y
4-1-19	Kawainui					Y			
4-1-20	Pipiwai								
4-1-21	Halawa	Y		Y	Y	Y	Y		Y
4-1-22	Hakaaano								
4-2-01	Pohakupili								
4-2-02	Honoulimaloo								
4-2-03	Honouliwai				Y				
4-2-04	Waialua								
4-2-05	Kainalu				Y				
4-2-06	Honomuni				Y				
4-2-08	Mapulehu				Y				
4-2-09	Kaluaaha								
4-2-10	Kahananui								
4-2-11	Manawai								Y
4-2-12	Ohia				Y				
4-2-13	Wawaia				Y				
4-2-14	Kamalo				Y				Y
4-2-15	Kawela				Y				
4-2-16	Papio								

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
Maui									
6-1-01	Ukumehame				Y	Y			
6-1-02	Olowalu				Y	Y		Y	
6-1-03	Launiupoku				Y	Y		Y	
6-1-04	Kauaula				Y				
6-1-05	Kahoma		Y	Y	Y	Y			
6-1-06	Wahikuli								
6-1-07	Honokowai		Y		Y	Y			
6-1-08	Kahana		Y		Y				
6-1-09	Honokahua		Y			Y			
6-1-10	Honolua		Y	Y				Y	
6-1-11	Honokohau		Y		Y	Y			Y
6-2-01	Poelua		Y						
6-2-02	Honanana		Y		Y				
6-2-03	Kahakuloa		Y		Y	Y	Y		
6-2-05	Waiolai								
6-2-06	Makamakaole		Y			Y			
6-2-07	Waihee R.				Y	Y			
6-2-08	Waiehu				Y				
6-2-09	Iao				Y	Y	Y		
6-2-10	Waikapu		Y	Y	Y			Y	
6-3-01	Maliko				Y				Y
6-3-02	Kuiaha				Y				
6-3-03	Kaupakulua				Y				
6-3-04	Manawaiiao								
6-3-05	Uaoa				Y				
6-3-07	Kakipi				Y				
6-3-08	Honopou				Y				Y
6-3-09	Hoolawa				Y				
6-3-10	Waipio				Y				
6-3-11	Hanehoi								
6-3-12	Hoalua							Y	
6-3-13	Hanawana								
6-3-14	Kailua				Y			Y	
6-3-15	Nailiilihaele				Y			Y	
6-4-01	Oopuola			Y				Y	
6-4-02	Kaaiea							Y	
6-4-03	Kolea								
6-4-04	Waikamoi		Y		Y	Y		Y	
6-4-06	Puohokamoa		Y		Y			Y	Y
6-4-07	Haipuaena		Y		Y			Y	Y
6-4-08	Punalau							Y	
6-4-09	Honomanu		Y	Y	Y			Y	
6-4-10	Nuaailua		Y		Y			Y	
6-4-11	Piinaau		Y		Y	Y	Y	Y	

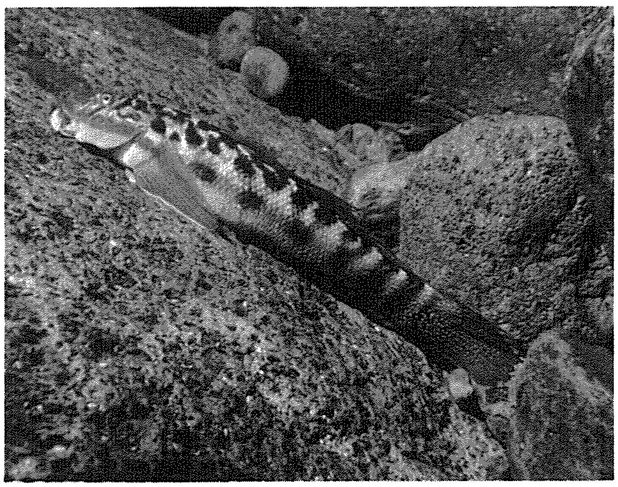
CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
6-4-12	Ohia								
6-4-13	Waiokamilo							Y	Y
6-4-14	Wailuanui		Y						Y
6-4-15	W. Wailuaiki		Y					Y	
6-4-16	E. Wailuaiki		Y		Y			Y	
6-4-17	Kopiliula		Y		Y			Y	Y
6-4-18	Waiohue Gl.					Y		Y	
6-4-19	Paakea					Y			
6-4-20	Waiaaka								
6-4-21	Kapaula		Y					Y	
6-4-22	Hanawi		Y			Y		Y	
6-4-23	Makapipi		Y			Y		Y	
6-4-24	Kuhiwa		Y					Y	
6-4-25	Waihole								
6-4-26	Manawaikeae							Y	
6-4-27	Kahawaihapapa							Y	
6-4-28	Keaaiki							Y	
6-4-29	Waioni							Y	
6-4-30	Lanikele							Y	
6-4-31	Heleleikeoha		Y					Y	
6-4-32	Kawakoe					Y			
6-4-33	Ulaino					Y	Y	Y	
6-4-34	Kawaipapa				Y				
6-4-36	Unnamed								
6-5-01	Moomoonui				Y				
6-5-02	Haneoo								
6-5-03	Kapia				Y	Y		Y	
6-5-04	Waiohonu				Y			Y	
6-5-05	Papaahawahawa								
6-5-06	Alaalaula								
6-5-07	Wailua					Y			Y
6-5-08	Honolewa					Y			Y
6-5-09	Waieli					Y			
6-5-10	Kakiweka					Y			
6-5-11	Hahalawe					Y			
6-5-12	Puaaluu					Y			
6-5-13	Oheo Gl	Y			Y	Y		Y	Y
6-5-15	Koukouai								Y
6-5-16	Opelu								
6-5-17	Kukuiula					Y			
6-5-18	Kaapahu								
6-5-19	Lelekea								
6-5-20	Alelele				Y	Y			
6-5-21	Kalepa				Y				
6-5-22	Nuanuaaloa								
6-5-24	Manawainui					Y			

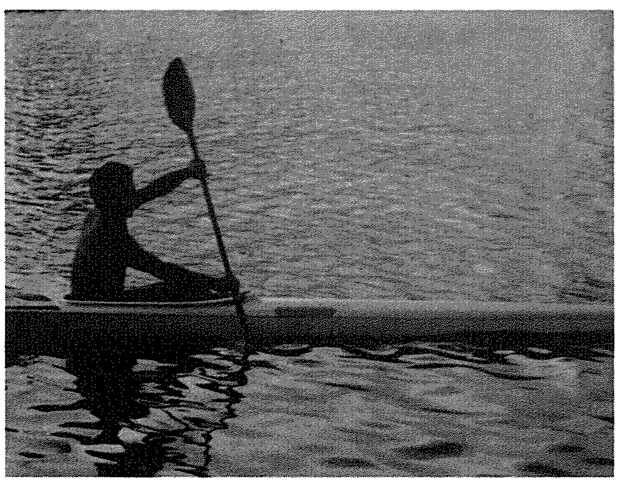
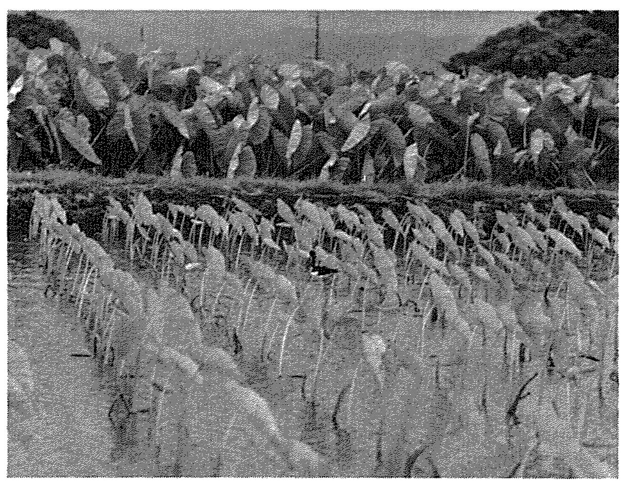
CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
Hawaii									
8-1-03	Kumakua				Y				
8-1-06	Hanaula				Y				
8-1-07	Hapahapai				Y				
8-1-08	Pali Akamoa								
8-1-09	Wainaia				Y				
8-1-10	Unnamed				Y				
8-1-11	Halawa				Y				
8-1-12	Aamakao				Y	Y			
8-1-13	Niulii	Y			Y				
8-1-14	Waikama				Y				
8-1-15	Pololu		Y	Y	Y	Y			
8-1-16	Honokane Nui		Y		Y	Y			
8-1-17	Honokane Iki				Y	Y			
8-1-18	Kalele Gl.								
8-1-19	Waipahi				Y				
8-1-20	Honokea				Y	Y			
8-1-21	Kailikaula								
8-1-22	Honopue				Y	Y			
8-1-23	Kolealiilii								
8-1-24	Ohiahuea				Y	Y			
8-1-25	Nakooko								
8-1-26	Waiapuka				Y				
8-1-27	Waikaloa				Y				
8-1-28	Waimaile								
8-1-29	Kukui								
8-1-30	Paopao				Y				
8-1-31	Waiaalala								
8-1-32	Punalulu				Y				
8-1-33	Kaimu		Y		Y	Y			
8-1-34	Pae		Y						
8-1-35	Waimanu		Y	Y	Y	Y			Y
8-1-36	Pukoa			Y					
8-1-37	Manuwaikaalio			Y					
8-1-38	Naluea			Y					
8-1-39	Kahoopuu			Y					
8-1-42	Waipahoehoe		Y	Y		Y			
8-1-44	Wailoa/Waipio		Y	Y	Y	Y			Y
8-1-45	Lalakea				Y				Y
8-1-46	Kaluahine Falls								
8-1-47	Waiulili								
8-1-49	Waipunahoe								
8-1-50	Waialeale								
8-1-51	Waikoloa					Y			
8-1-52	Kapulena								

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
8-1-53	Kawaikalia				Y				
8-1-54	Malanahae								
8-1-61	Nienie				Y				
8-1-62	Papuaa								
8-1-65	Kahaupu				Y				
8-1-66	Kahawailiili				Y				
8-1-67	Keahua								
8-1-68	Kalopa				Y				
8-1-69	Waikaalulu				Y				
8-1-70	Kukuilamalamahii				Y				
8-1-71	Alilipali				Y				
8-1-73	Kaumoali Gl				Y				
8-1-76	Waipunahina				Y			Y	
8-1-77	Waipunalau Gl				Y				
8-1-78	Paauilo				Y				
8-1-79	Aamanu				Y				
8-1-80	Koholalele Gl				Y				
8-1-81	Kalapahapu Gl				Y				
8-1-82	Kukaiau				Y				
8-1-85	Kaala				Y				
8-1-86	Kealakaha							Y	
8-1-88	Kupapaulua				Y			Y	Y
8-1-89	Kaiwiki								
8-1-90	Kaula				Y				
8-2-01	Kaohaoha								
8-2-02	Kaawalii				Y	Y			
8-2-03	Waipunalei								
8-2-04	Laupahoehoe				Y			Y	
8-2-05	Kilau		Y		Y	Y			
8-2-06	Manowaiopae				Y	Y			
8-2-07	Kuwaikahi					Y			
8-2-08	Kihalani				Y				
8-2-09	Kaiwilahilahi		Y		Y	Y		Y	
8-2-10	Haakoa		Y		Y				
8-2-11	Pahale								
8-2-12	Kapehu				Y	Y			
8-2-13	Paeohe				Y				
8-2-14	Maulua				Y				
8-2-16	Pohakupuka								
8-2-17	Kulanakii								
8-2-18	Ahole								
8-2-19	Poupou								
8-2-20	Manoloa					Y			
8-2-21	Ninole					Y			
8-2-22	Kaaheiki								
8-2-23	Waikolu								

CODE	NAME	PRK	HAB	MAR	WET	DES	ED	HIS	WF
8-2-24	Waikaumalo	Y			Y				
8-2-25	Kahuku								
8-2-26	Waiehu								
8-2-27	Nanue				Y	Y			
8-2-28	Opea				Y	Y			
8-2-29	Peleau					Y			
8-2-30	Umauma		Y		Y			Y	
8-2-31	Kamaee								
8-2-32	Hakalau		Y	Y	Y	Y		Y	
8-2-33	Kolekole	Y	Y	Y		Y		Y	Y
8-2-34	Paheehee				Y	Y			
8-2-35	Honomu				Y	Y			
8-2-36	Laimi								
8-2-37	Kapehu					Y			
8-2-38	Makea								
8-2-39	Alia								
8-2-40	Makahanaloa								
8-2-41	Waimaauou								
8-2-42	Waiaama							Y	
8-2-43	Kawainui			Y	Y				
8-2-44	Onomea								
8-2-45	Alakahi								
8-2-46	Hanawi				Y				Y
8-2-47	Kalaoa								
8-2-48	Aleamai								
8-2-49	Kaieie				Y				
8-2-50	Puuokalepa				Y			Y	
8-2-51	Kaapoko					Y			
8-2-52	Papaikou								
8-2-53	Kapue		Y						
8-2-54	Pahoehoe								
8-2-55	Paukaa								
8-2-56	Honolii		Y	Y	Y	Y	Y	Y	Y
8-2-57	Maili				Y				
8-2-59	Pukihae			Y	Y			Y	
8-2-60	Wailuku R.		Y	Y	Y	Y		Y	Y
8-2-61	Wailoa R.		Y	Y					Y
8-2-62	Kaahakini								Y
8-4-02	Waiaha								
8-5-01	Haloa								
8-5-02	Lamimaumau								
8-5-03	Waikoloa				Y				

Resource Inventory and Assessment



Resource Inventory and Assessment

One purpose of this study was to identify those streams with the high value stream-related "beneficial uses." These were developed after extensive surveys of users. The first task was to categorize these uses, or "resources," into more manageable units.

- Aquatic Resources
- Riparian Resources
- Cultural Resources
- Recreational Resources

Committees were established to inventory and assess each resource area. The committees consisted of people knowledgeable in the resource area and a state official from the department responsible for the management of the resource.

Each committee identified the elements to be inventoried, and, using those elements, design the criteria for assessing streams. Recommended stream rankings were Outstanding, Substantial, Moderate, Limited, and Unknown. Each committee was given the option of using one or more of these ranks. The Aquatic Committee added a sixth ranking: Without.

The committees reviewed the assessment of the streams, which was based on the inventory data and the criteria, and made adjustments based on their collective expertise. The committees participated in the writing and approved the final report.

Every committee ranked streams reluctantly. The common concern was that users of the report would interpret all streams not ranked Outstanding as being unworthy of protection. This was not the design or intent of the Hawaii Stream Assessment, and neither this report nor the ranks should be used in that way. A ranking of Outstanding was based on good information being available. In some cases streams not ranked Outstanding may have resources as good as those classified as such, but were ranked otherwise because of incomplete or inadequate information. Therefore, it should be emphasized that this report and assessment is general in nature and is a first step. While it should serve as a flag for areas of concern, and may suggest where development might take place, it does not substitute for any review, survey or other study normally required of a project.

Finally, this inventory and assessment was the first attempt at such a task in Hawaii. The inventory elements and criteria represent each committee's best attempt to quantify and qualify enormously complex subjects, and the discussion of how and even if this could be accomplished was intense in every group. The committees did their best, and, after more than a year of meeting, acknowledge that the results are useful and important, yet imperfect.

Members of the committees agreed to assess, knowing that not every stream in Hawaii can be protected for its stream-related values, but hoping that this study may help protect a few. If some are to be protected, they should be the best ones.

Aquatic Resources

Hawaiian streams support a small but unique aquatic fauna, including freshwater fish, mollusks, crustaceans, and insects. Although the diversity of native species in Hawaii's streams is low, most of those species are found only in the Hawaiian islands.

A number of these unique native stream animals have a life cycle involving both the stream and the sea. This type of life history, in which an animal lives its entire adult life in fresh water and its early larval period in the ocean, is called amphidromy.

The common perception among aquatic biologists is that Hawaii's native stream fauna is limited in abundance and distribution, however these characteristics are not well documented. Better understanding of the life history and habitat requirements of the native aquatic fauna is needed in order to manage the natural resources for their survival.

An inventory and assessment of Hawaii's native aquatic resources were needed to inform and assist managers of those resources. An advisory committee of aquatic biologists and resource managers was formed to obtain expert input on the design and development of such an inventory and assessment. The Aquatic Resources Committee was responsible for overseeing the inventory of the available information and the assessment of streams.

Although the habitat requirements of certain stream animals are not fully understood, the committee assumed that their presence indicated that conditions necessary for their survival were also present. Since at least some of the native species traverse or use the entire length of the stream in their life history, conditions on any part of the stream may affect these species. Therefore, the entire stream was considered important as a single unit and assessment of streams by segments was considered inappropriate.

An important first step for this inventory was a search of all available published literature, unpublished reports and field notes. The Board of Land and Natural Resources contracted with The Nature Conservancy's Hawaii Heritage Program to compile all the literature available on biological resources of Hawaiian streams. Personal observations were obtained from the committee and active aquatic biologists. A complete list of sources consulted is provided.

Available biological information for individual streams was entered on standardized data sheets, (Table 20)and then were entered into the HSA database.

The committee established assessment criteria to identify streams containing ecosystems with potentially high quality aquatic resources. They identified four key native species considered to be indicators of the health of the native aquatic ecosystem. The assessment criteria were based on the presence and abundance of the indicator species, evidence of their spawning, and on unaltered stream conditions. Based on these criteria, streams were ranked as Outstanding, Substantial, Moderate, Limited, Without, Unknown. Aquatic insects were not considered only because their taxonomy and distribution are poorly understood.

Using the information in the data sheets, the Aquatic Resources Committee reviewed the rankings. In those few cases where the rank derived from the database conflicted with the committee's collective expert opinion, the committee adjusted the rankings.

Of 376 perennial streams, 164 (44 percent) have some biological information. Based on the committee's criteria, 73 streams are ranked outstanding, 19 Substantial, 36 Moderate, 27 Limited, 12 Without, and 212 (56 percent) Unknown.

Background

Prior to human habitation in the Hawaiian islands most continuous streams may have been occupied by one or more native stream species. Adult gobies and certain invertebrates breed in streams or estuaries, and the newly hatched larvae are swept out to sea where they become part of the marine zooplankton. After a protracted period of development the postlarvae enter stream mouths and begin a migration upstream.

Native Hawaiian stream species are often described as "current loving" (rheophylic). Their native habitats include clear, well-oxygenated stream water that flows over boulders, cobbles, and gravel. Gobiid gobies are uniquely adapted to life in turbulent coastal waters and streams, and have modified (fused) ventral fins that function as suction disks. This adaptation allows them to 'climb' waterfalls and colonize stream sections inaccessible to other fishes. Kinzie (in press) has summarized details on the taxonomy, life history, ecology, and management of amphidromous fishes, crustaceans, and mollusks found in Hawaiian streams.

The populations and distributions of amphidromous native stream animals have been reduced in modified streams, especially those in which the physical habitat, flow regime, water temperature and chemistry have been significantly altered. Studies by Timbol and Maciolek (1978) showed that 15 percent (55 of 366) of all perennial streams had been significantly altered by channel modification before 1978 and that the biological quality and condition of nearly 75 percent (275) of Hawaii's perennial streams had been degraded.

The introduction of non-native aquatic species, many of which appear to be highly successful competitors or predators, may have also reduced the original distribution and abundance of Hawaii's unique stream fauna in recent years. Oahu streams appear to be the most affected by stream alterations and introduced species.

Methods

Committee

The Aquatic Resources Committee consisted of seven aquatic biologists and resource managers. They directed all aspects of the inventory and assessment. The committee approved the procedures for summarizing observations of aquatic fauna and habitat, developed ranking criteria for assessing the biological significance of individual streams, and reviewed all final ranks. They also provided bibliographies, reprints and access to files containing significant information sources on Hawaiian stream fauna.

Aquatic Resource Committee
Chair, Audrey Newman, TNCH
William Devick, DAR, DLNR
John Ford, USFWS
John Harrison, UH Manoa Environmental Center
Luciana Honigman, TNCH
Robert Kinzie, UH Manoa Zoology
James Parrish, UH Cooperative Fishery Research Unit

Inventory

A great deal of relevant literature on aquatic species exists, but it is widely scattered and highly variable. The inventory prepared by the Hawaii Heritage Program is based on literature made available to them up to February 1990.

All available information on the distribution and abundance of freshwater species on the five main Hawaiian islands (Hawaii, Maui, Molokai, Oahu, and Kauai) was compiled. The major references were the limnological surveys by Shima in the 1960s (Shima, unpub). More recent reports included surveys by Archer (1981, 1982, 1983, 1984, 1985), Archer et al. (1980), Ford and Kinzie (unpub.), Heacock (1984, unpub), Kinzie and Ford (1977, 1982), Maciolek (1971, 1972, 1977), Maciolek and Timbol (1981), Norton (1976, 1977), Timbol (1972, 1977, 1979, 1982, 1983, 1986), and Timbol et al. (1980a, 1980b). A complete list of sources consulted, including personal communications, is provided in the bibliography.

Due to the amphidromous nature of the life cycle of the native freshwater fauna and their presumed need to use the entire stream, each stream was considered as a unit, and not in segments. Types of information included in the inventory were presence, abundance and spawning of native species, occurrence and abundance of introduced species, habitat factors, and information sources. In this aquatic report the *u'ina* (glottal stop) is incorporated into the Hawaiian names of aquatic animals only.

Native Species: Eleven native species were classified into two groups, depending on their scarcity (Table 17).

Native Species Group 1 (NG1): Four native freshwater species were classified as "indicator species" and comprised the Native Species Group One (NG1). The committee considered these as representatives of potentially high quality stream ecosystems. They included three gobies and a mollusk. Of the four NG1 Species, only *'o'opu alamo'o* (*Lentipes concolor*) is listed by the USFWS (1989) as a candidate endangered species. However, the Aquatic Resources Committee believes that two other *'o'opu* (*Awaous stamineus* and *Sicyopterus stimpsoni*), as well as the *hihiwai* (*Neritina granosa*) may be declining in Hawaiian streams.

Table 17 Aquatic Species Groups

Native Species Group One (NG1)

Scientific name	Hawaiian name	Type
Awaous stamineus	'O'opu nakea	Goby
Lentipes concolor	'O'opu hiukole 'O'opu alamo'o	Goby
Neritina granosa	Hihiwai	Snail
Sicyopterus stimpsoni	'O'opu nopili	Goby

Native Species Group Two (NG2)

Scientific name	Hawaiian name	Type
Atyoida bisulcata	'O'pae kala'ole	Shrimp
Eleotris sandwicensis	'O'opu okuhe 'O'opu akupa 'O'apu oau 'O'apu owau	Eleotrid
Kuhlia sandvicensis	Aholehole	Kuhliid
Macrobrachium grandimanus	'O'pae 'oeha'a	Prawn
Mugil cephalus	'Ama'ama	Mullet
Stenogobius genivittatus	'O'opu naniha	Goby
Theodoxus vespertinus	Hapawai	Snail

Introduced Species Group One (IG1)*

Scientific name	Common name
Cichlasoma nigrofasciatum	Convict cichlid
Clarias fuscus	Chinese catfish
Corbicula fluminea	Clam
Gambusia affinis	Mosquito fish
Macrobrachium rosenbergii	Malaysian prawn
Micropterus dolomieu	Smallmouth bass
Poecilia spp.	Guppy (Limia, Topminnow)
Tilapia (*Sarotherodon, Oreochromis*) spp.	Tilapia
Xiphophorous spp.	Swordtail

* *Macrobrachium lar* is excluded because it is believed to be present in nearly all Hawaiian streams

Introduced Species Group Two (IG2)

All those species not listed in IG1; considered innocuous or accidental.

Native Species Group 2 (NG2): The other seven native species considered more common comprised Native Species Group Two (NG2). These included two stream and two marine fishes, one shrimp, one prawn, and one snail. Presence of these species was considered to be typical of a healthy native stream ecosystem.

Introduced Species: The committee divided the introduced (non-native) species into two groups depending on their potential threat to native species.

Introduced Species Group One (IG1): This group included noxious, non-native stream animals that may prey upon and/or out-compete with native species. *Macrobrachium lar*. (Tahitian prawn), was not included in this group even though it may pose a threat to native stream animals because it is believed to be present in almost all Hawaiian streams. Thus, no stream is "pristine" and the presence of *Macrobrachium lar* cannot be used for comparing stream quality.

Introduced Species Group Two (IG2): This consists of the non-native species considered to be innocuous to Hawaiian streams.

Data Sheets: Available biological information compiled for each stream was summarized in a three-page data sheet (Table 20). These data sheets included the presence and abundance of both native and introduced species. When available, physical information was included. The total numbers of native species observed were then summarized by group (NG1 and NG2) and were this way used to rate the abundance and diversity of native species in the stream.

The second page of the data sheet contained information on presence and abundance of introduced species.

The Factor Summary Table on the third page of the data sheet noted the total number of native and introduced species, along with ratings for diversity, spawning and recruitment, habitat quality, dams, diversions and channelizations (Table 20).

Assessment

To assess and compare the biological quality of individual streams, the Aquatic Resources committee developed a ranking system based primarily on the presence and abundance of the four native species believed to be indicators of potentially outstanding habitat.

Little information is available on aquatic habitat. Because of the data available, almost the only criteria that seemed to be applicable broadly across most streams, were biological, ie. based on presence and abundance of the various species. In large measure, this accounts for the specific criteria chosen for Outstanding (and other) categories.

Concern about the scarcity of *Lentipes concolor* seemed to make any stream where it is at least common a potentially very important resource, i.e. Outstanding.

Observation of egg mass or gravid females constitued evidence of spawning. While it is likely that frequent spawning by NG1 gobies occurs in many streams, not enough about their biology is known to say. Until or unless it becomes clear that there are many such streams for all the NG1 species, any that are known must be considered especially valuable, i.e. Outstanding.

While there are a good many streams where NG1 species are reported, there are relatively few where each individual species is reported as abundant. Each species is important because of its relative rarity. Abundance suggests strongly that populations are well established and are more likely to be reproducing locally, as opposed to being composed of strays or ephemeral groups. Therefore, the relatively few streams with known strong populations of any NG1 species are very valuable, i.e. Outstanding.

All four NG1 species are reported in relatively few streams. The requirements of some species seem rather different. The presence of all four species suggest high quality habitat, i.e., Outstanding.

Aquatic Resources Ranking Criteria

Outstanding
Either A or B
A. Any of these criteria
-*Lentipes concolor* is common in any reach of the stream.
-Evidence of spawning by any of the NG1 gobies.
-An abundance (abundant or very abundant) of any of the four rare NG1 species anywhere in the stream.
(This might indicate special significance for spawning.)
-Presence of all of the four NG1 species in the stream.

B. All of these criteria
-Two or more representatives of NG1 and NG2 each, representing high native species diversity.
-One or fewer IG1 introduced species
-No dams, diversions, or channelization.

Substantial
Both A and B
A. At least three total representatives from NG1 and NG2.
B. One or fewer introduced species IG1.

Moderate
Presence of at least one native species from NG1.

Limited
Presence of at least one NG2.

Without
No native species present.

Unknown
Insufficient biological information available for the stream.

Individual streams were then assigned to one of the six ranking categories. To apply these criteria to large stream systems, observations of the main stream and its tributaries were summarized together, and the highest rank earned by any segment of the stream was assigned to the entire stream. This procedure represents a simplification of the real system, but it acknowledges that amphidromous species may use much of a stream system at some life stage and require suitable habitat there. Other limitations to the assessment are discussed at the end of this report.

The Aquatic Resource Committee reviewed the initial rankings. In a few cases, where appropriate, it changed the rank based on personal observations as well as habitat quality.

Results

Inventory

Biological information was obtained for 178 streams, 45 percent of Hawaii's total of 376 streams. All except 18 of these studies were conducted on continuous streams. Of the total number of streams studied, 63 (K16, O28, Mo2, Ma12, Hi5) were surveyed since 1984, and 122 since 1974 (K36, O29, Mo5, Ma27, Hi25). NG1 species were found to be present in 111 of these streams. Only 6 streams had any records of spawning and only 16 of spawning and/or recruitment, possibly because these events are extremely difficult to observe.

The records of dams, diversions and channelization in the aquatic resources report were taken exclusively from the biological reports, although better sources for this information exist. The Hawaii Stream Assessment has more complete information about these modifications from other sources. Much of the literature suggested that the presence of these modifications may negatively affect native aquatic habitat. Modification information is included in the database for further correlation work. (Tables 7, 10)

Assessment

Of the 178 streams with biological information, 74 fulfilled the criteria for Outstanding. Breaking that down according to specific criteria, the results are as follows: *Lentipes concolor* was common in 44 streams. NG1 were abundant or very abundant in 47 streams (K12, O5, Mo4, Ma15, Hi11), and spawning of NG1 fish was observed in 6 streams. All four NG1 species were recorded in 20 streams. (K10, O0, Mo2, Ma 6, Hi2). Criteria B, which took diversity and habitat into account, was met by 12 streams.

Discussion

Continuous perennial streams are the principal habitat for native stream species. Extensive water development is incompatible with outstanding aquatic resources. The maps and data suggest that outstanding aquatic resources tend to be concentrated in the less developed areas, particularly the north shores of Kauai, Molokai and a small section of Oahu, and several areas on Maui. Survey coverage summarized in this report is geographically more complete for Oahu, Kauai and Maui than for Molokai and Hawaii.

While the concern about the viability of native aquatic species is high, scientific information to guide management efforts is limited. The Aquatic Resources committee endorses Robert Kinzie's expression of concern related to stream management:

> A serious deterrent to the formulation of rational management practices for native amphidromous species is the lack of knowledge of their population biology, larval life history, and genetic structure. Two possible extreme scenarios illustrate the problems involved. In the first instance, while a species may

be found in both large and small streams, only a few or even one breeding population may be responsible for the bulk of the reproductive output of the entire species. In this case, habitat destruction in the majority of the streams would have little impact on the species as a whole, but any degradation of the primary breeding stream could be disastrous. Because so little is known about the genetic structure of any of these species or about the ocean current patterns among the islands, we could not identify which streams would be the important ones if this scenario were true.

At the other extreme, it is possible that each stream with a population of adults contributes recruits to the total species pool in proportion to the adult population size, modified by chance events including unusual streamflow events, offshore currents, and conditions at potential settling sites. In this case, reduction of the suitability of any stream would reduce the reproductive potential of the total population in proportion to the reduction in numbers of adults in the stream.

The actual situation probably lies somewhere between these two extremes, but because of an almost total lack of information, judgements cannot be made about the relative expendability of any potential breeding population. Given this situation, the most careful review should be given to any proposed action that could potentially interfere with the link between the freshwater habitats and the sea. Because we cannot evaluate the potential effects of an action on the species, extreme caution is advised in each instance where any of the native populations are threatened by a proposed activity, particularly in the critical lowland elevations (Robert A. Kinzie III, Amphidromous Macrofauna of Island Streams, 1990).

Similar concerns apply to the aquatic environments that form the interface between streams and the sea. There are no comprehensive studies to define the biological significance for stream fauna of estuaries and embayments. However, the available evidence and general ecological experience suggests that these environments provide important habitat for marine and migrating freshwater animals. A list of estuaries and embayments (Table 14) is in the Special Areas section of this report.

These stream ranking criteria simplify the many complex factors important to native stream ecosystems. For example, physical characteristics may be very important predictors of stream habitat quality for native species. However, it was not possible to use these characteristics uniformly as criteria, because the available information was limited and inconsistent. The presence of aquatic insects was also not considered, as their distributions are not well understood.

While the presence of native species is a good indication of valuable resources, their absence during a limited survey may not mean that they are absent from the stream. Some of the surveys are old and may not reliably indicate the current status of the stream. Others are very selective in their scope, and do not provide complete data for the scope of this study. There is no information for over half of the perennial streams. The percent of coverage for continuous perennial streams, however, is much higher. Therefore, it is important to note that the available data provide only a limited view of the actual distribution of stream animals.

A stream might be inappropriately ranked Limited because only a few species were seen on a single survey, and might actually qualify for higher rank. In contrast, an Outstanding stream is clearly indicated by its high reported species diversity or abundance.

Spawning and recruitment events are unpredictable in time and sometimes occur during periods of flooding, when observation is difficult or hazardous. Thus, the limited observations of spawning and recruitment cannot be interpreted as a statement about the frequency or distribution of these events, only that the information has not been collected.

This Aquatic Resources report represents a summary of available surveys and observations of Hawaiian streams. It should not be construed as a reliable assessment of the quality of stream habitats or of the occurrence and distribution of biota within or between streams. It is not the final arbiter of the biological importance of a given stream. It should not be substituted either for needed research or the proper biological reconnaissance surveys that should be performed and carefully reviewed before development is seriously considered. It is instead a document that should provide valuable source material for future research and for evaluation of potential impacts from developments.

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Figure 3 Native Aquatic Species Illustrations

Eleotris sandwicensis,
'o'opu okuhe or
'o'opu akupa

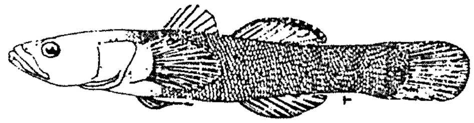


Figure 1. Eleotris sandwicensis 8.5-cm (SL) male

Stenogobius genivittatus,
'o'opu naniha

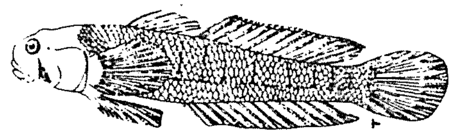


Figure 2. Stenogobius genivittatus 5.5-cm (SL) male

Awaous stamineus,
'o'opu nakea

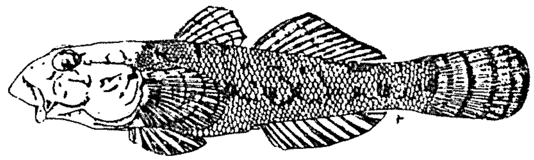


Figure 3. Awaous stamineus 9.0-cm (SL) male

Sicyopterus stimpsoni,
'o'opu nopili

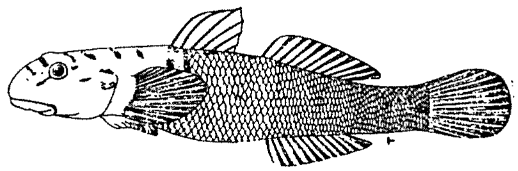


Figure 4a. Sicyopterus stimpsoni 5.5-cm (SL) female

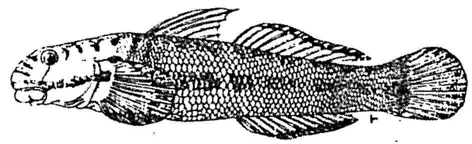


Figure 4b. Sicyopterus stimpsoni 5.5-cm (SL) male

Lentipes concolor,
'o'opu alamo'o or
'o'opu hi'ukole

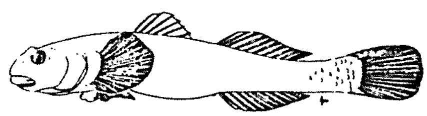


Figure 6a. Lentipes concolor 4.0-cm (SL) female

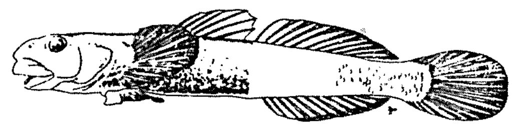


Figure 6b. Lentipes concolor 5.8-cm (SL) male

Macrobrachium grandimanus,
'opae 'oeha'a

Atyoida bisulcata,
'opae kala'ole

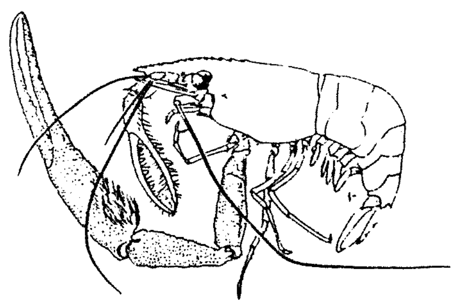


Figure 8. Macrobrachium grandimanus 22-mm POCL (Male)

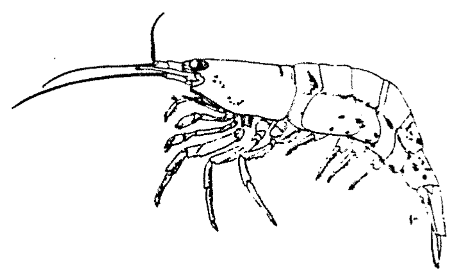


Figure 7. Atyoida bisulcata 8 mm (Post-Orbital Carapace length (POCL).

Neritina granosa,
hihiwai or wi

Neritina vespertina,
hapawai

Figure 10a. Neritina granosa downstream morph 3-cm shell width

Figure 10b. Neritina granosa upstream morph 2-cm shell width

Figure 11. Neritina vespertina 1 5-cm shell width

Source: Kinzie, R.S., III, 1989, Species Profiles.

Table 18 Aquatic Resources

CODE HSA code; island-hydrographic unit-stream (system)

STREAM Stream name at mouth

RANK Aquatic Ranking determined by the HSA Aquatic Resources Committee

- L Outstanding
- M Moderate
- O Outstanding
- S Substantial
- U Unknown
- W Without

Alamoo

- Y oopu alamoo. Lentipes concolor, has been observed.

Nakea

- Y oopu nakea. Awaous stamineus, has been observed.

Nopili

- Y oopu nopili. Sicyopterus stimpsoni, has been observed.

Hihiwai

- Y Hihiwai. Neritina granosa, has been observed.

NG2 Number of NG2 species observed

IG1 Number of introduced species (IG1)

Year Last Year Last surveyed

Surv Number of surveys

Last Surv Year of most recent survey

* Rank changed from O on basis of degradation of habitat subsequent to studies

** Rank raised on basis of evaluation of habitat and data

*** Rank lowered from M on basis of habitat degradation

CODE	STREAM	RANK	Alamoo	Nakea	Nopili	Hihiwai	#NG2	#IG1	#Surv	Last Surv
Kauai										
2-1-01	Awaawapuhi	O	Y	Y	Y	Y	1		1	84
2-1-04	Kalalau	O	Y	Y	Y	Y	2		7	89
2-1-05	Pohakuao	O	Y				1		2	80
2-1-07	Hanakoa	O	Y	Y	Y		1	1	3	89
2-1-08	Waiahuakua	O	Y				1		2	80
2-1-09	Hoolulu	L					1		2	80
2-1-10	Hanakapiai	O	Y	Y	Y	Y	2	1	12	89
2-1-11	Maunapuluo	O	Y	Y	Y	Y	1		4	89
2-1-12	Limahuli	O	Y	Y	Y		2		5	89
2-1-13	Manoa	S	Y	Y	Y		1		1	89
2-1-14	Wainiha R.	O	Y	Y	Y	Y	6	3	11	89
2-1-15	Lumahai R.	O	Y	Y	Y	Y	7	1	10	89
2-1-16	Waikoko	W							1	78
2-1-17	Waipa	S		Y			3	1	2	66
2-1-18	Waioli	S		Y	Y		3	1	1	66
2-1-19	Hanalei R.	O	Y	Y	Y	Y	6	5	7	86
2-1-20	Waileia	M		Y					1	89
2-1-21	Anini	M		Y			6	3	5	89
2-1-25	Kalihiwai R.	O		Y	Y	Y	6	2	5	79
2-1-26	Puukumu	M		Y			1	1	3	89
2-1-28	Kilauea	M		Y		Y	7	5	5	89
2-1-29	Kulihaili	S		Y	Y	Y	5	1	1	79
2-1-30	E. Waiakalua	S		Y	Y		3		1	79
2-1-31	Pilaa	L					1		1	79

CODE	STREAM	RANK	Ala-moo	Nakea	Nopili	Hihi-wai	#NG2	#IG1	#Surv	Last Surv
2-1-32	W. Waipake	W							1	79
2-1-33	E. Waipake	S				Y	6		1	79
2-1-34	Moloaa	L					4	4	1	79
2-2-01	Anahola	O	Y	Y	Y	Y	4	3	4	89
2-2-02	Kumukumu	L					1	1	1	78
2-2-04	Kapaa	O	Y	Y			5	4	4	90
2-2-06	Waikaea Canal	U							1	79
2-2-08s	Wailua S.	M		Y	Y	Y	6	7	10	90
2-2-12	Hanamaulu	L					1	3	2	66
2-2-15	Huleia	O		Y			6	7	4	90
2-3-02	Waikomo	M		Y			2	4	2	90
2-3-04	Lawai	M		Y	Y		3	2	1	78
2-3-07	Hanapepe	M		Y	Y		4	3	3	78
2-4-03	Waipao	U							1	78
2-4-04s	Waimea S.*	M		Y	Y	Y	7	3	5	90
2-5-15	Milolii	O	Y	Y	Y	Y	2		2	84
2-5-16	Nualolo	O	Y	Y	Y	Y	3		2	84
				Oahu						
3-1-07	Kahawainui	L					1		1	84
3-1-09	Koloa Gl.	O		Y	Y	Y	1		3	90
3-1-10	Kaipapau	L					1		1	84
3-1-11	Maakua	L					1		2	84
3-1-13	Kaluanui	O	Y	Y	Y	Y	5	4	8	90
3-1-16	Punaluu	O		Y	Y	Y	5	4	7	89
3-1-18	Kahana**	O		Y	Y		7	6	13	90
3-1-19	Kaaawa	O		Y			1	2	1	84
3-1-20	Makaua	O		Y			1		1	84
3-2-01	Hakipuu	M		Y			2	3	3	84
3-2-02	Waikane	M		Y			5	3	4	84
3-2-04	Waiahole	M		Y			5	4	10	84
3-2-05	Kaalaea	M		Y			5	4	4	84
3-2-07s	Kahaluu S.*	M		Y			6	5	11	84
3-2-08	Heeia	M		Y			7	5	7	84
3-2-09	Keaahala	M		Y			4	4	5	84
3-2-10	Kaneohe*	M		Y			6	6	15	89
3-2-11	Kawa***	U						5	5	84
3-2-13	Kawainui/ Maunawili***	L		Y			1	5	8	84
3-2-14	Kaelepulu Canal	W						3	1	84
3-2-15	Waimanalo	M		Y			2	3	1	84
3-3-07s	Ala Wai S.	M		Y			7	6	6	89
3-3-09	Nuuanu	L					4	4	3	89

CODE	STREAM	RANK	Ala-moo	Nakea	Nopili	Hihi-wai	#NG2	#IG1	#Surv	Last Surv
3-3-11	Kalihi	M		Y			4	5	3	89
3-4-02	Halawa	W						1	2	89
3-4-06	Waiawa	W						1	2	69
3-4-10	Waikele	W						5	3	89
3-5-07	Makaha	M		Y			1	2	2	76
3-6-06s	Kiikii S.	M		Y			3	6	4	89
3-6-07s	Paukauila	O	Y	Y			3	7	3	89
3-6-08s	Anahulu S.	S		Y			1		2	69
3-6-09	Loko Ea	W							1	85
3-6-10	Waimea R.	M	Y	Y	Y		3	2	5	89
				Molokai						
4-1-03	Waikolu	O	Y	Y	Y	Y	3		6	87
4-1-06	Waiohookalo	O	Y		Y	Y	1		2	90
4-1-09	Pelekunu	O	Y	Y	Y	Y	8		5	89
4-1-15	Wailau	O	Y						8	88
4-1-19	Kawainui	U							1	66
4-1-21	Halawa	O	Y	Y	Y		4		3	80
4-2-04	Waialua	U							2	73
4-2-14	Kamalo	W							1	90
4-2-15	Kawela	W							1	90
				Maui						
6-1-01	Ukumehame	S		Y	Y		2		6	90
6-1-02	Olowalu	S		Y	Y		1	1	6	90
6-1-04	Kauaula	W							2	63
6-1-05	Kahoma	M		Y			1		4	90
6-1-07	Honokowai	L					1		3	63
6-1-09	Honokahua	U							2	63
6-1-10	Honolua	L					1		3	63
6-1-11	Honokohau	O	Y	Y	Y	Y	5	1	8	90
6-2-03	Kahakuloa	O		Y	Y		4		6	90
6-2-06	Makamakaole	O	Y	Y	Y		2		2	90
6-2-07	Waihee R.	O	Y	Y	Y		1	1	8	90
6-2-08	Waiehu	S		Y	Y		1		3	63
6-2-09	Iao	S		Y	Y		2	1	5	90
6-2-10	Waikapu	S		Y	Y		1		3	63
6-3-09	Hoolawa	L					1		4	80
6-3-14	Kailua	M			Y		1		2	63
6-3-15	Nailiilihaele	L					1		2	63
6-4-04	Waikamoi	W					1		5	90

CODE	STREAM	RANK	Ala-moo	Nakea	Nopili	Hihi-wai	#NG2	#IG1	#Surv	Last Surv
6-4-06	Puohokamoa	L					1		2	63
6-4-07	Haipuaena	L					1		2	63
6-4-08	Punalau	L								
6-4-09	Honomanu	L					1		3	90
6-4-10	Nuaailua	L					1		2	63
6-4-11	Piinaau	O	Y	Y	Y	Y	1		7	90
6-4-13	Waiokamilo	U							2	63
6-4-14	Wailuanui	O	Y		Y		1		5	80
6-4-15	W. Wailuaiki	M					1		6	90
6-4-16	E. Wailuaiki	M				Y	1		5	90
6-4-17	Kopiliula	M				Y	1		2	63
6-4-18	Waiohue Gl.	O	Y	Y	Y	Y	7	1	8	90
6-4-19	Paakea	M				Y			1	79
6-4-21	Kapaula	L					1		2	63
6-4-22	Hanawi	O	Y	Y	Y	Y	2		11	84
6-4-23	Makapipi	O	Y	Y	Y		1		5	90
6-4-32	Kawakoe	O	Y				1		2	80
6-5-03	Kapia	O	Y	Y					2	80
6-5-07	Wailua	O	Y	Y	Y				2	80
6-5-08	Honolewa	O	Y	Y	Y				2	80
6-5-09	Waieli	O	Y		Y		1		3	80
6-5-10	Kakiweka	O	Y		Y		1		5	90
6-5-11	Hahalawe	O	Y						4	90
6-5-12	Puaaluu	O	Y	Y	Y	Y	1		5	84
6-5-13	Oheo Gl	O	Y	Y	Y	Y	4		10	80
6-5-17	Kukuiula	O	Y	Y	Y		1		2	80
6-5-20	Alelele	O	Y		Y	Y			3	90
6-5-24	Manawainui	O	Y	Y			1		3	80
Hawaii										
8-1-12	Aamakao	O	Y						2	80
8-1-15	Pololu	U							2	69
8-1-16	Honokane Nui	M			Y		1		2	69
8-1-20	Honokea	U							2	69
8-1-35	Waimanu	M		Y		Y	7	2	6	90
8-1-38	Naluea	L					1		3	76
8-1-42	Waipahoehoe	L					1		3	76
8-1-44	Wailoa/Waipio	O	Y	Y	Y	Y	2	1	2	69
8-1-45	Lalakea	O		Y	Y		2	1	2	69
8-1-51	Waikoloa	W							2	69
8-1-89	Kaiwiki	U								
8-1-90	Kaula	U							2	69
8-2-02	Kaawalii	O	Y	Y	Y		1		2	80

CODE	STREAM	RANK	Ala-moo	Nakea	Nopili	Hihi-wai	#NG2	#IG1	#Surv	Last Surv
8-2-04	Laupahoehoe	U							2	69
8-2-05	Kilau	O	Y				1	1	2	80
8-2-06	Manowaiopae	O	Y		Y		1		2	80
8-2-07	Kuwaikahi	O	Y				1		2	80
8-2-09	Kaiwilahilahi	O	Y				1		4	80
8-2-12	Kapehu	O	Y				1		4	80
8-2-14	Maulua	O		Y	Y		1		2	69
8-2-16	Pohakupuka	O	Y		Y		1	1	2	69
8-2-20	Manoloa	O	Y		Y		1		5	90
8-2-21	Ninole	O	Y				1		3	80
8-2-23	Waikolu	U							1	69
8-2-24	Waikaumalo	L					1	1	3	79
8-2-27	Nanue	O	Y	Y	Y	Y	1	1	2	69
8-2-28	Opea	O	Y			Y	1	1	4	80
8-2-29	Peleau	O	Y				1	1	2	80
8-2-30	Umauma	S	Y	Y	Y		1	1	5	90
8-2-32	Hakalau	O	Y	Y	Y		3	2	5	80
8-2-33	Kolekole	O		Y	Y	Y	2	1	4	79
8-2-34	Paheehee	O	Y	Y	Y		3	2	3	69
8-2-35	Honomu	O	Y	Y	Y		1	1	4	80
8-2-37	Kapehu	O	Y				1	1	3	80
8-2-42	Waiaama	L					1	1	2	69
8-2-43	Kawainui	M		Y			2	1	2	69
8-2-45	Alakahi	S								
8-2-46	Hanawi	O	Y	Y	Y	Y	1	1	2	69
8-2-49	Kaieie	L					1	1		
8-2-51	Kaapoko	O	Y				1	1	2	80
8-2-53	Kapue	M		Y			1	2	3	80
8-2-54	Pahoehoe	S		Y	Y	Y	4	1	2	69
8-2-56	Honolii	O	Y	Y	Y	Y	1	1	4	89
8-2-57	Maili	O		Y	Y	Y	2	1	2	69
8-2-59	Pukihae	S	Y	Y	Y		2	1	5	90
8-2-60	Wailuku R.	M	Y	Y	Y		1	2	12	90
8-2-61	Wailoa R.	S		Y			2		1	90
8-5-03	Waikoloa	W							2	69

Table 19 Outstanding Aquatic Resources

Streams ranked outstanding in Aquatic Resources and the criteria satisfied to be outstanding.

- CODE — HSA code; island-hydrographic unit-stream
- STREAM — Stream Name at mouth
- Ala-moo — Y - *Lentipes concolor* common
- Spa-wn — Y - Evidence of spawning by NG1* goby
- NG1 Abn — Y - Abundance of any NG1*
- NG1 4 — Y - All 4 NG1 species present
- Crit B — Y - Good diversity and habitat as per criteria B
- Qual — Quality of information
  - E — Excellent
  - G — Good
  - P — Poor

CODE	STREAM	Ala moo	Spa wn	NG1 Abn	NG1 4	Crit B	Qual
Kauai							
2-1-01	Awaawapuhi				Y		G
2-1-04	Kalalau	Y		Y	Y	Y	E
2-1-05	Pohakuao	Y		Y			G
2-1-07	Hanakoa	Y		Y			E
2-1-08	Waiahuakua	Y		Y			G
2-1-10	Hanakapiai	Y	Y	Y	Y	Y	E
2-1-11	Maunapuluo	Y		Y	Y		E
2-1-12	Limahuli					Y	E
2-1-14	Wainiha R.		Y	Y	Y		E
2-1-15	Lumahai R.		Y	Y	Y	Y	E
2-1-19	Hanalei R.		Y	Y	Y		E
2-1-25	Kalihiwai R.			Y			E
2-2-01	Anahola			Y	Y		E
2-2-04	Kapaa	Y		Y			E
2-2-15	Huleia			Y			E
2-5-15	Milolii				Y	Y	E
2-5-16	Nualolo				Y	Y	G
Oahu							
3-1-09	Koloa Gl.			Y			E
3-1-13	Kaluanui			Y			E
3-1-16	Punaluu		Y	Y			E
3-1-18	Kahana						E
3-1-19	Kaaawa			Y			E
3-1-20	Makaua			Y			G
3-6-07	Paukauila S.			Y			G
Molokai							
4-1-03	Waikolu	Y		Y	Y		E
4-1-06	Waiohookalo	Y		Y			G
4-1-09	Pelekunu	Y	Y	Y	Y	Y	G
4-1-15	Wailau	Y					E
4-1-21	Halawa	Y		Y		Y	G
Maui							
6-1-11	Honokohau				Y		E
6-2-03	Kahakuloa			Y		Y	E
6-2-06	Makamakaole			Y			E
6-2-07	Waihee R.	Y		Y			E
6-4-11	Piinaau	Y		Y	Y		E
6-4-14	Wailuanui	Y		Y			G
6-4-18	Waiohue Gl.	Y		Y	Y		E
6-4-22	Hanawi	Y	Y	Y	Y		E
6-4-23	Makapipi	Y		Y			E
6-4-32	Kawaikae	Y					G
6-5-03	Kapia	Y		Y			G
6-5-07	Wailua	Y		Y			G
6-5-08	Honolewa	Y		Y			G
6-5-09	Waieli	Y		Y			E
6-5-10	Kakiweka	Y		Y			E
6-5-11	Hahalawe	Y		Y			
6-5-12	Puaaluu	Y		Y	Y		E
6-5-13	Oheo Gl	Y		Y	Y	Y	E
6-5-17	Kukuiula	Y		Y			G
6-5-20	Alelele			Y			E

6-5-24	Manawainui	Y		Y			G
CODE	STREAM	Ala moo	Spa wn	NG1 Abn	NG1 4	Crit B	Qual
Hawaii							
8-1-12	Aamakao	Y		Y			G
8-1-44	Wailoa/ Waipio				Y		P
8-1-45	Lalakea					Y	P
8-2-02	Kaawalii	Y		Y			G
8-2-05	Kilau	Y		Y			G
8-2-06	Manowaiopae	Y		Y			G
8-2-07	Kuwaikahi	Y		Y			G
8-2-09	Kaiwilahilahi	Y		Y			G
8-2-12	Kapehu	Y		Y			G
8-2-14	Maulua			Y			P
8-2-16	Pohakupuka	Y		Y			P

CODE	STREAM	Ala moo	Spa wn	NG1 Abn	NG1 4	Crit B	Qual
8-2-20	Manoloa	Y		Y			E
8-2-21	Ninole	Y		Y			G
8-2-27	Nanue			Y	Y		P
8-2-28	Opea	Y		Y			G
8-2-29	Peleau	Y		Y			G
8-2-32	Hakalau	Y		Y			G
8-2-33	Kolekole			Y		Y	E
8-2-34	Paheehee			Y			G
8-2-35	Honomu	Y		Y			G
8-2-37	Kapehu	Y		Y			G
8-2-46	Hanawi			Y	Y		P
8-2-51	Kaapoko	Y		Y			G
8-2-56	Honolii	Y		Y	Y		E
8-2-57	Maili			Y		Y	P

Table 20 Methodology For Data Collection and Sample Data Sheet

The available biological information compiled for each stream is summarized in a three page data sheet. Each data sheet is identified with the name of the stream, the HSA stream code, and the list of sources used. The sources are coded with the first letter indicating the type of source (unpublished, book field notes, personal communications), the two numbers following are the last two digits of the year in which it was prepared or published; following are the first three letters of the first author's last name. The last two digits are a tie breaker. For example, in Attachment 2* the first source is U88FOR01. This refers to an unpublished report prepared in 1988 by John Ford and Andy Yuen.

The first page contains information on the presence, abundance or absence of native species observed. For each species, the maximum abundance (Max) and most current observation (Cur) with their respective years were recorded. If only one observation was made at a particular stream, the information was recorded in the current observations column. When the abundance in the most current survey and the maximum abundance were the same, then the information was recorded under the current column with the most current date adjacent to it.

While aquatic biologists commonly use "abundant," "very abundant," "common," and so forth, there is no commonly accepted numerical standard for defining these terms. Thus, the distinction between them is imprecise and somewhat subjective.

Information on spawning (Spn) and/or recruitment (Rcrt) was also recorded. Native aquatic plant or animal species not listed on the data sheet were written in below the species list.

The total number of native species observed was then summarized by group in the table in the middle of page 1. The totals for NG1 and NG2 species were later used to rate the abundance and diversity of native species in the stream.

The second page of the data sheet lists introduced species. The information on presence and abundance of introduced species was recorded in the same way as for native species. At the bottom of page 2 is a table summarizing the total number of introduced species observed in the stream by group. Marcrobachium lar was noted separately.

The Factor Summary Table on page three noted the total number of NG and IG species, along with ratings for diversity, spawning and recruitment. Habitat quality, dams, diversions and channelizations were ranked only if mentioned specifically in the biological sources consulted for this project. Timbol and Maciolek (1978) was not referenced. Otherwise these factors were ranked as "U".

HAWAII STREAM ASSESSMENT
AQUATIC RESOURCES
DATA SHEET
(Sample)

STREAM: Pelekunu (+ tributaries)
STREAM CODE: 4-1-09
SOURCES: U88FOR01, U88FWS01, F89FOR01, U66SHI03, U67SHI01

ABUNDANCE

Name	Common Name	Max	Yr	Cur	Yr	Spn	Rcrt	Comments
NATIVE								
Crustaceans								
** Atyoida (Atya) bisulcata	*'opaekala'ole*	C	66	C	89			
** Macrobrachium grandimanus	*'opae 'oeha'a*	C	66	X	88			
Fishes								
* Awaous (Chonophorus) stamineus	*'o'opu nakea*			V	89	X	X	appear to school, gravid ♀ several size classes
** Eleotris sandwicensis	*'o'opu okuhe, akupa*			X	88			
** Kuhlia sandvicensis	*aholehole*			C	88			
* Lentipes concolor	*'o'opu alamo'o*			V	89	X		appear to school, gravid ♀
** Mugil cephalus	mullet			X	88			
* Sicyopterus (Sicydium) stimpsoni	*'o'opu nopili*			V	89	X	X	appear to school, gravid ♀ several size classes
** Stenogobius (Awaous, Chonophorus) genivittatus	*'o'opu naniha*			X	88			
Unidentified goby	*'o'opu*							
Molluscs								
Assiminea sp.								
Melanoides (Melania) sp.				X	88			
* Neritina granosa	*hihiwai, wi*	A	66	C	89	X		
** Theodoxus cariosus								
** Theodoxus vespertinus	*brown wi*			X	88			
Polychaete								
Namalycastis abiuma (Lycastis hawaiiensis)								
Sponge								
Heteromyenia baileyi								

TOTAL	Numbers
NATIVES	12
NG1 (*)	4
NG2 (**)	8
OTHER	

damselfly nymphs P 66
Ferrissia sharpi X 88
Erinna aulacospira X 88
Pseudosidora rubella X 88
marine fishes may be seen (U88FOR01)
other crustaceans may be seen (U88FOR01)

IN STREAM FLORA PRESENT
filamentous green algae (U66SHI03)

legend:
x = present
- = absent
v = very abundant
a = abundant
c = common or fair
p = poor or few
= unknown

Abbreviations:
Max = maximum abundance
Yr = year
Cur = most current observation
Spn = spawning
Rcrt = recruitment

Hawaii Heritage Program
Date/Initials: 89-08-31 LH
QC: 89-08-30 KBL

HAWAIIAN STREAM ASSESSMENT
AQUATIC RESOURCES DATA SHEET
CONTINUED (page 2)
STREAM: Pelekunu
STREAM CODE: 4-1-09

ABUNDANCE

Name	Common Name	Max	Yr	Cur	Yr	Spn	Rcrt	Comments
NON-NATIVE								
Crustaceans								
Macrobrachium lar	Tahitian prawn			X	88			
+ Macrobrachium rosenbergii	Malasyan prawn							
Procambarus clarkii	crayfish							
Fishes								
Ancistrus sp.								
Astronotus ocellatus								
Barbus semifasciolatus								
Carassius auratus								
Cichla ocellaris								
+ Cichlasoma sp.	cichlid							
+ Clarias fuscus	catfish							
Colossoma macropomum								
Cyprinus carpio								
Dorosoma petenense								
+ Gambusia affinis	mosquito fish							
Hypostomus sp.								
Ictalurus punctatus								
Lepomis macrochirus								
Leporinus sp.								
+ Micropterus sp.	bass							
Misgurnus anguillicaudatus								
Monopterus albus (Flutea alba)								
Oncorhynchus mykiss								
Ophicephalus striatus								
+ Poecilia sp.	guppy							
Pterophyllum sp.								
Pterygoplichthys multiradiatus								
Strongylura kreffti								
+ Tilapia sp.	tilapia							
+ Xiphophorus sp.	swordtail							
Molluscs								
+ Corbiculea fluminea	clam							
Helisoma sp.								
Viviparus chinensis								
Amphibians								
Bufo marinus								
Rana spp.								
Bryozoans								
Lophopodella carteri								
Plumatella repens								
Turtles								
Chrysemys scripta elegans								
Trionyx sinensis sinensis								

TOTAL	Numbers
EXOTICS	1
EG1 (+)	Ø
EG2	Ø
M. lar	1

000198

HAWAII STREAM ASSESSMENT
AQUATIC RESOURCES DATA SHEET
CONTINUED (page 3)

STREAM: Pelekunu
STREAM CODE: 4-1-09

TABLE OF STREAM RANK

		COMMENTS
INITIAL	outstanding	all NG1 present, Lentipes very abundant, ØEG1
COMMITTEE		
FINAL	outstanding	

FACTOR SUMMARY TABLE

Factor	Rank*	Comments
Native Species Group 1 (NG1)	E	4
Native Species Group 2 (NG2)	E	8
Native Species Diversity	E	
Native Species Spawning or Recruitment	E	
Exotic Species Group 1 (EG1)	Ø	M. lar only
Exotic Species Group 2 (EG2)	Ø	
Habitat Suitability	(E)	excellent U88 R&Ø1
Dams and Diversions	E	
Channelization	E	
Data Quality	G	2 surveys, 1 recent

Legend: E = excellent
G = good
P = poor
U = unknown

* For exotic species the number of species observed rather than a rank is assigned
Dams and diversions and channelization factors include only information
other than Timbol and Maciolek 1978

Criteria for Additional Aquatic Resources Factors

Native Species Group One (NG1)

E = More than two species present or two species present with at least one common to abundant.
G = Two species present or one species that is common to abundant.
P = Fewer than two species present and uncommon.

Native Species Group Two (NG2)

E = More than two species present or two species present with at least one common to abundant.
G = Two species present or one species that is common to abundant.
P = Fewer than two species present and uncommon.

Native Species Diversity

E = At least two species present from each of the groups NG1 and NG2.
G = At least one species present from each of the groups NG1 and NG2.
P = One or fewer species present from groups NG1 or NG2.

Native Species Spawning or Recruitment

E = Evidence of significant spawning or recruitment by any NG1 fish.
G = Evidence of significant spawning or recruitment by any NG2 species or occasional spawning by any NG1 species.
P = No spawning or recruitment by NG1 or NG2 species.

Introduced Species Group One (IG1)

Codes were not used for introduced species; the number of species present was recorded instead. IG1 does not include insects.

Introduced Species Group Two (IG2)

Codes were not used for introduced species; the number of species present was recorded instead. IG2 does not include insects.

Habitat Suitability*

E = Good pools and riffles with a gentle slope in the lower reaches, gravel bottom with minimal sedimentation, and continuous water flows with low turbidity except during freshets.
G = Steep slope in the lower reaches with nearly continuous to intermittent water flows or gentle slope with significant sedimentation.
P = Limited intermittent water flows with extended disappearance of riffles.

* Habitat was only ranked if mentioned specifically in the biological sources consulted, otherwise it was ranked "U"

Dams and Diversions

E = No dams or diversions.

G = No dams or diversions in the middle to lower reaches.

P = Dams or diversions below the upper reaches or a loss of 50% of the mean annual flow.

Channelization

E = No channelization.

G = Channelization limited to grading or straightening with retention of a gravel substrate.

P = Concrete linings, chutes, or flumes installed.

Data Quality

E = Two or more recent surveys (1975 - present).

G = At least one recent survey.

P = one or more surveys, all prior to 1975.

Legend:

E = excellent, G = good, P = poor, U = unknown

Note: This is supplemental information that was used to rank the stream directly. The ranking or the streams came from the database based on the definitions by advisors.

Map 4

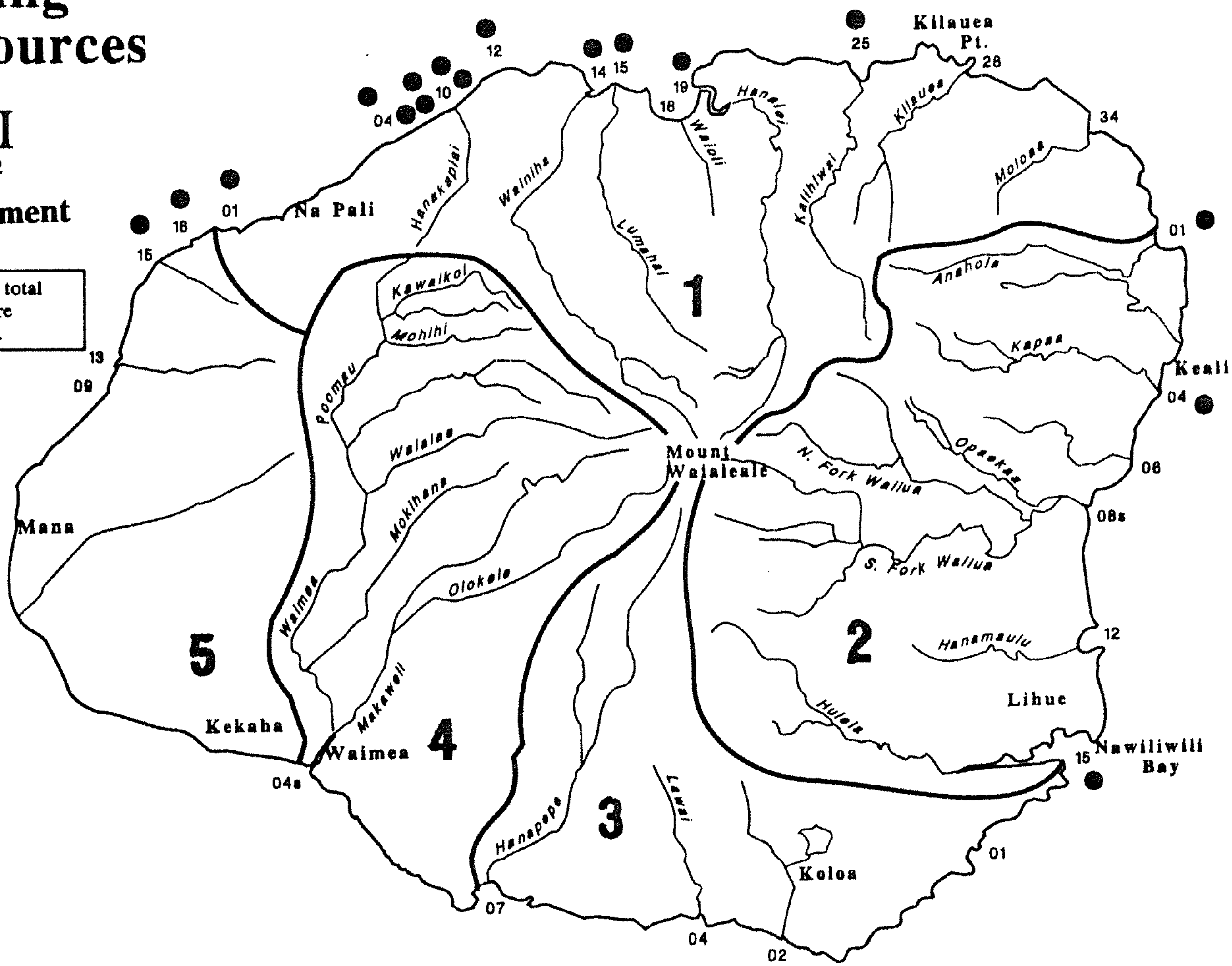
Outstanding Aquatic Resources

KAUAI

Island Code - 2

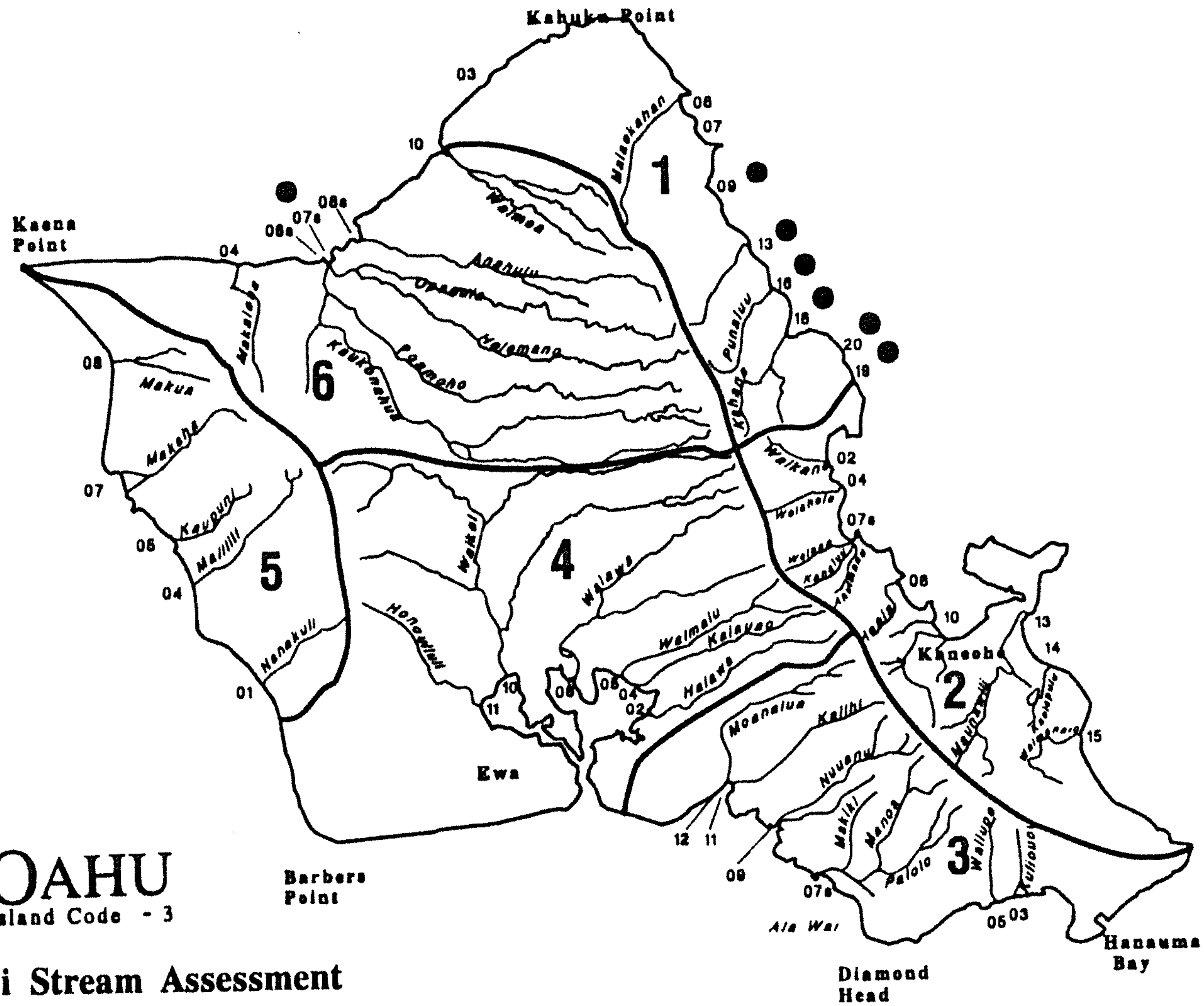
Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.



2-1-01 Awaawapuhi
2-1-04 Kalalau
2-1-05 Pohakuao
2-1-07 Hanakoa
2-1-08 Waiahuakua
2-1-10 Hanakapiai
2-1-12 Limahuli
2-1-11 Maunapuluo
2-1-14 Wainiha R.
2-1-15 Lumahai R.
2-1-19 Hanalei R.
2-1-25 Kalihiwai R.
2-2-01 Anahola
2-2-04 Kapaa
2-2-15 Huleia
2-5-15 Milolii
2-5-16 Nualolo

Map 4
Outstanding Aquatic Resources



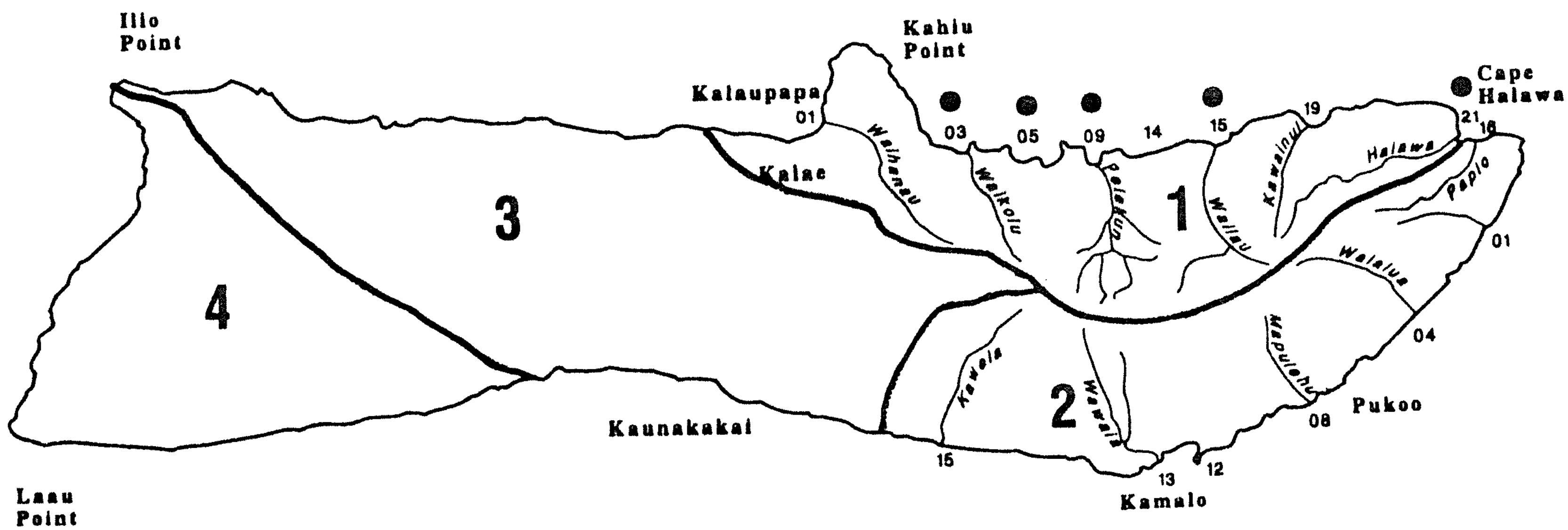
3-1-09	Koloa Gl.
3-1-13	Kaluanui
3-1-16	Punaluu
3-1-18	Kahana
3-1-19	Kaaawa
3-1-20	Makaua
3-6-07s	Paukauila S.

OAHU
Island Code - 3

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Map 4 Outstanding Aquatic Resources



4-1-03 Waikolu
4-1-06 Waiohookalo
4-1-09 Pelekunu
4-1-15 Wailau
4-1-21 Halawa

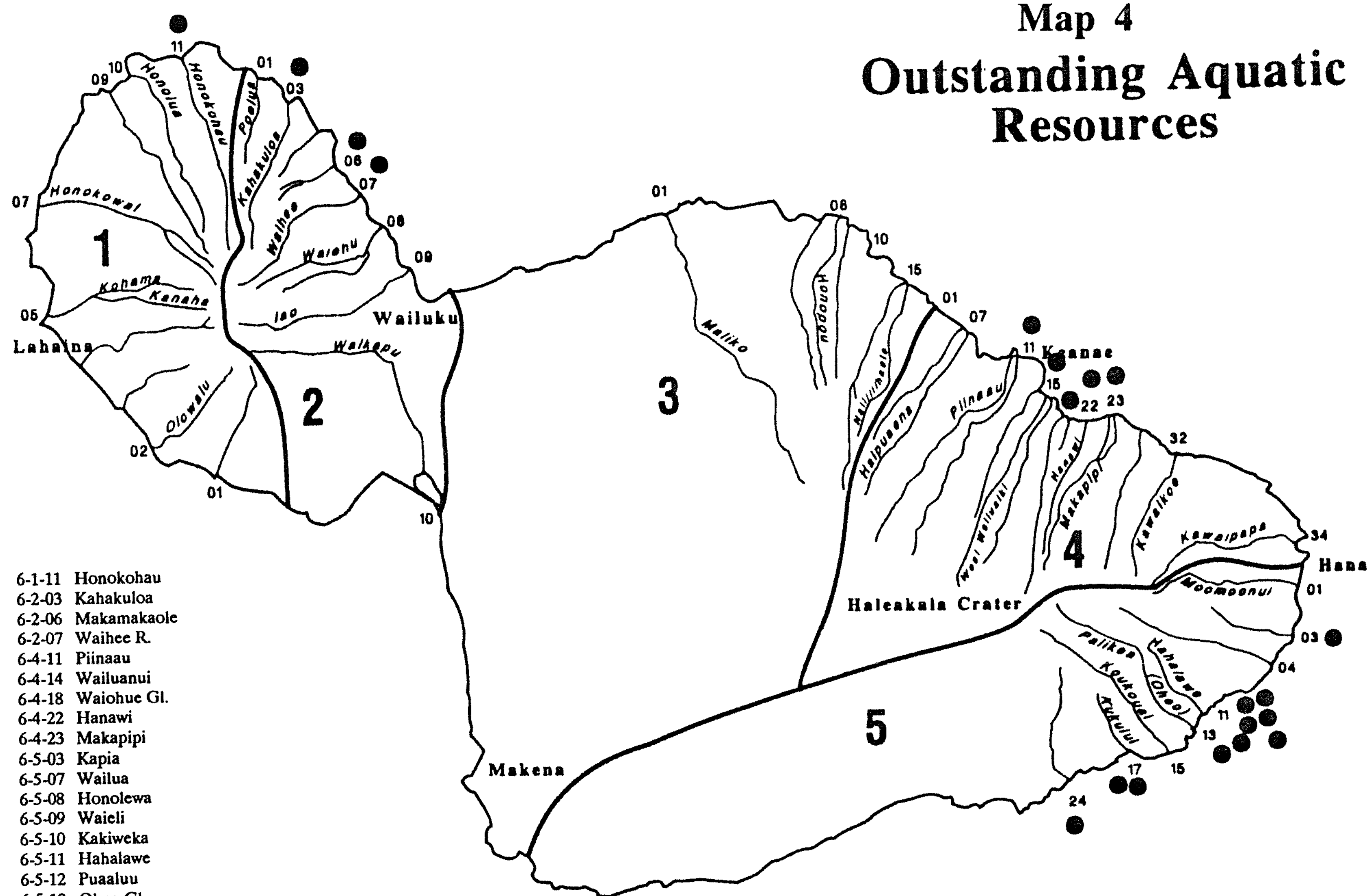
MOLOKAI

Island Code - 4

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 4
Outstanding Aquatic Resources



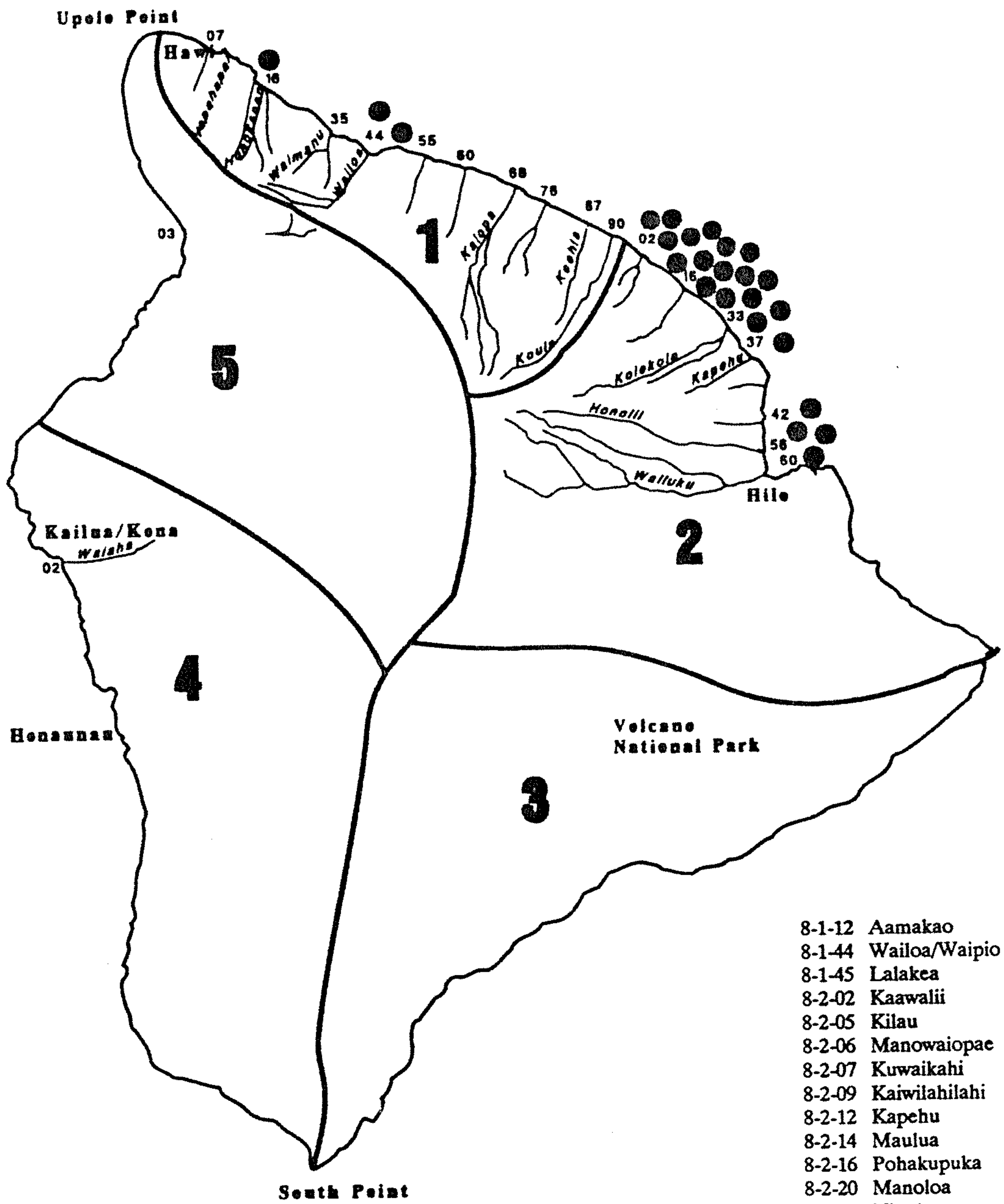
6-1-11 Honokohau
6-2-03 Kahakuloa
6-2-06 Makamakaole
6-2-07 Waihee R.
6-4-11 Piinaau
6-4-14 Wailuanui
6-4-18 Waiohue Gl.
6-4-22 Hanawi
6-4-23 Makapipi
6-5-03 Kapia
6-5-07 Wailua
6-5-08 Honolewa
6-5-09 Waieli
6-5-10 Kakiweka
6-5-11 Hahalawe
6-5-12 Puaaluu
6-5-13 Oheo Gl
6-5-17 Kukuiula
6-5-20 Alelele
6-5-24 Manawainui

MAUI
Island Code - 6

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 4
Outstanding Aquatic Resources



8-1-12 Aamakao
8-1-44 Wailoa/Waipio
8-1-45 Lalakea
8-2-02 Kaawalii
8-2-05 Kilau
8-2-06 Manowaiopae
8-2-07 Kuwaikahi
8-2-09 Kaiwilahilahi
8-2-12 Kapehu
8-2-14 Maulua
8-2-16 Pohakupuka
8-2-20 Manoloa
8-2-21 Ninole
8-2-27 Nanue
8-2-28 Opea
8-2-29 Peleau
8-2-32 Hakalau
8-2-33 Kolekole
8-2-34 Paheehee
8-2-35 Honomu
8-2-37 Kapehu
8-2-46 Hanawi
8-2-51 Kaapoko
8-2-56 Honolii
8-2-57 Maili

HAWAII
Island Code - 8

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Riparian Resources

Streams are dependent on and affected by the physical and biological entities that surround them and compose their watersheds. No statewide inventory or assessment of Hawaiian watersheds has been conducted, even though their deterioration has been a concern since the turn of the century (Hall 1904, Judd 1931). This inventory has, therefore, concentrated on known stream-associated resources (e.g., rare, threatened and endangered species and communities, protected areas, wetlands, native forests) because of their intrinsic value and because their presence or absence provides an indication of the status of the watershed. This indirect approach to assessing watershed quality is very limited and identifies an important area where research is needed.

Riparian resources have been defined in U.S. mainland stream assessments to include everything within a strip extending either a quarter of a mile or 1,000 feet on each side of a stream or river. But an arbitrary fixed distance from the stream was considered inappropriate to define riparian resources in Hawaii. A Hawaiian stream may pass through narrow gorges, plunge down cliffs in excess of 2,000 feet and/or meander through broad flood plains during its short course to the ocean. Therefore, natural resources are considered riparian in this assessment if they:

- could affect the quality of the stream;
- could be affected by changes in stream management;
- were adjacent to and possibly dependent on the stream.

Many riparian resources in Hawaii have been addressed in a broad array of publications. The most comprehensive report, the U.S. Fish and Wildlife Service's (USFWS) Forest Bird Survey (Scott et al. 1986), includes distribution maps of various resources. Several databases have been compiled: wetland plants (USFWS 1989); wetland physical data (U.H. Environmental Center 1989); and rare plant distribution (The Nature Conservancy of Hawaii's ongoing Heritage Program). Government agency files and maps, particularly those of the USFWS and the state Division of Forestry and Wildlife, provided information on rare plants, weeds, vegetation type, etc. Data from all of these sources have been abstracted and incorporated into the inventory and assessment compiled by this project.

All of the categories of riparian resources inventoried for the assessment are biological/ecological. The committee considered for a time the inclusion of notable geologic features such as the exposures of pillow lavas at the base of Wailua Falls on the South Fork of the Wailua River and at the Menehune Ditch next to the Waimea River, both on Kauai. However, the committee decided that, on the one hand, the association of such features with the streams was insufficient to warrant their inclusion in the inventory and, on the other hand, the features having significant influence on stream characteristics (such as the dikes responsible for springs) were too ubiquitous to warrant inclusion.

Background

Many factors in the surrounding area affect the purity of water in a stream; e.g., the status of the surrounding vegetation, the areal extent of unvegetated soil, and the presence of animals. The role of vegetation is complex. It controls runoff directly as well as the recharge of groundwater, which may affect stream flow downslope. Vegetation also prevents or reduces soil erosion, which directly affects the purity of streamwater. Disturbance from alien influences can exacerbate the natural processes of erosion enormously. Adjacent land uses can affect streams directly and indirectly.

The ideal riparian assessment would evaluate the quality of the watershed in conjunction with the unique or special features and organisms found within it. However, information on the condition of watersheds in Hawaii is fragmentary at best. On the other hand, the distribution of Hawaii's native organisms, especially the more charismatic species, is reasonably well-documented and is the focus of this inventory and assessment.

Many rare native species are dependent on undisturbed habitat. Their presence is, therefore, an indication of the integrity of the native vegetation. The presence of a substantial native forest similarly indicates that alien disturbances are minimal. All native organisms and communities have evolved in these habitats over the millennia and are adapted to Hawaii's environment and its inherent variability. Their presence along a stream course indicates that "natural" (pre-Cook or perhaps even pre-Polynesian discovery) processes are still occurring. It is presumed that a greater extent of native forest and number of rare communities and species indicate a higher level of native ecological processes in the watershed and consequently an ecosystem better adapted to Hawaiian conditions.

Wetlands are important riparian resources but many have been drained and converted to agricultural or urban uses. The conservation of those that remain is of critical importance to the USFWS.

Conservation of Hawaii's unique heritage by national parks, wildlife refuges, natural area reserves, and private preserves provide special protection from exploitation and degradation. Few streams are protected throughout their course with preservation of riparian resources and processes a primary management objective. Yet the presence of these areas along a part of a stream reduces the risk of degradation and is therefore a favorable feature.

Some alien animals and plants (i.e., those introduced since 1778) have a negative influence on streams. Feral animals (e.g., pigs, sheep, goats), none of which are native to Hawaii, destroy vegetation, open up forests, accelerate soil erosion, and contaminate the water with fecal material. Weedy plants can dramatically alter the nature of a stream generally by impeding water flow. Three species California grass, hau, and red mangrove are considered to have the greatest influence. The presence of any of these animals or plants along a stream course has the potential to disrupt the natural processes. Each species has a characteristic impact, the cumulative effects of which can be compounded sigificantly.

Methods

Committee

The definition of riparian resources, identification of sources, methods of gathering information and development of criteria for this inventory and assessment were conducted by a committee of six people from federal, state and private agencies. The committee met seven times between February 1989 and June 1990. Occasionally, specialists and other interested individuals also participated.

Riparian Resource Committee

Co-Chair John Harrison, UH Environmental Center;
Co-Chair Clifford Smith, Unit Leader CPSU/UH;
Doak Cox, retired UH Manoa;
Audrey Newman, TNCH;
Ron Walker, Wildlife Manager DLNR;
Andy Yuen, USFWS or John Ford, USFWS.

Inventory

The riparian inventory elements are: Listed threatened and endangered species; Recovery habitats; Other rare organisms and communities; Protected areas; Wetlands; Native forest; and, Detrimental organisms.

Listed threatened and endangered species. These species are generally dependent on undisturbed habitat. Their presence is, therefore, an indication of the integrity of the native vegetation. We consider the presence of these species along a stream course to be a positive attribute; the more types of threatened and endangered species associated with a stream the higher the value of the resource. Only federally listed threatened or endangered forest or water birds that have been extensively documented within the last 15 years are included. No stream associated plant has been officially listed as endangered or threatened to date. Sources used include Scott et al. (1986); TNCH Hawaii Heritage database; Wagner, Herbst and Sohmer (1990); USFWS wetland plant inventory database.

Recovery habitat. Recovery habitat consists of those areas identified by the USFWS (1985) and DLNR as essential for the recovery of threatened and endangered species. Streams that have recovery habitat anywhere along their length are included.

Other rare organisms and communities. Many species that are candidates for endangered or threatened status have not been processed through all of the requirements of the Endangered Species Act. Also a number of plant communities associated with streams have become extremely rare. We consider these rare organisms and communities to be as indicative of natural Hawaiian biological processes as are listed threatened and endangered species. Species listed as candidate endangered species by the USFWS, or classified G1 (5 or fewer populations or less than 1,000 individuals) or G2 (between 6-20 populations and 1,001-3,000 individuals) by TNCH Hawaii Heritage database, or considered rare by experienced field botanists (Obata; Wagner, Herbst and Sohmer) are included in this category. Species are listed only if their presence has been confirmed in the last 15 years.

Protected areas. The riparian resources of streams that pass through natural area reserves, refuges and other protected areas are accorded special protection from degradation. Protected areas were so designated because of features other than their riparian resources. The presence of these areas along a stream, however, indicates that native processes are promoted and alien influences controlled. Streams that pass through areas protected by the federal government (National Park, National Wildlife Refuge, National Natural Landmarks, and National Estuarine Research Reserve), state government (Natural Area Reserves, Wildlife Sanctuary, Plant Sanctuary, and Marine Life Conservation District) as well as areas not under state or federal management (The Nature Conservancy Hawaii Preserves) are included. Forest reserves, recorded in the database, are not included because they have not been evaluated. State and county parks are also excluded because their principal function is recreation not conservation. Sources for this information include Atlas of Hawaii, HSA Recreation Committee; State Division of Parks and Recreation; NARS Maps; DAR, Eric Onizuka; HRS 13-125-3; USGS maps; and DOFAW Carolyn Corn.

Wetlands. Wetlands are important riparian resources. They provide habitat for many species and are often important nursery areas. Because they are often extensive areas of flat land generally with deep soil, many have been drained and converted to agricultural or urban uses. Those that remain are, therefore, invaluable as well as being indicators of lack of disturbance. Three enumerations of wetlands have been produced in Hawaii: Elliott & Hall (1977), UH Environmental Center (1990), and USFWS (1978). The Elliott & Hall and Environmental Center systems are quite specialized.

Native forest. The proportion of a stream course flowing through native forest provides an indication of the potential "naturalness" on the quality of a stream's watershed; the greater the percentage of a stream flowing through native forest most of which is protected in forest reserves the more significant the resource. Only the length of the main course of a stream (to the nearest 10 percent) that passes through native forest was recorded. Inclusion of all tributaries was beyond the scope of the project due to time constraints. Streams were measured from vegetation map overlays on topographic quad maps. Small pockets of native vegetation within alien vegetation and vice versa were ignored. The data was obtained from the Hawaii Forest Bird Survey maps (Scott et al. 1986) for Hawaii, Maui and Molokai. Oahu's native forest limits were from personal consultation with Obata. Kauai's were from Scott et al. (1986) supplemented by information from Perlman. Other information was obtained from Jacobi (1989).

Detrimental organisms. Some animals and plants have a negative influence on streams. Wild animals (e.g., pigs, goats, deer) destroy vegetation, open up forests, accelerate soil erosion, and contaminate the water with fecal material. Weedy plants can dramatically alter the nature of a stream generally by impeding water flow. Three species, California grass, hau, and red mangrove, are considered to have the greatest influence. The presence of any of those animals on plants along a stream course is considered a potentially negative factor. The degree of detriment is dependent on the number of species present. These species were identified by DOFAW wildlife biologists and Smith in consultation with R. Hobdy, L. Stemmermann, P. Higashino, S. Perlman.

Assessment

The assessment of riparian resources was conducted in two separate phases. First the seven elements listed below were evaluated for each stream.

1. Listed threatened and endangered species.
Number of species.

2. Recovery habitat.
Presence/absence of recovery habitat.

3. Other rare organisms and communities.
Number of species.
Number of rare communities.

4. Protected areas.
Presence/absence and streams protected along their whole length were also noted.

5. Wetlands.
Number of wetlands according to three different classifications.

6. Native forest.
Percentage (to the nearest 10 percent).

7. Detrimental organisms.
Number of species present.

The committee tried five different combinations of the above data, settling on the one presented.

The number of organisms, etc., in the various categories was ranked as shown below rather than using total numbers. In this way, overweighting due to very high numbers in some categories was reduced. Detrimental organisms were not considered.

Threatened or Endangered Birds
1-3 species present = 1 point.
4-7 species present = 2 points.
8+ species present = 3 points.

Recovery Habitat
Presence = 2 points.

Rare Plants and Communities
1-3 species present = 1 point.
4-7 species present = 2 points.
8+ species present = 3 points.

Protected Area
Part of stream = 1 point.
Entire stream = 2 points.

Wetland

Small wetlands = 1 point.
Large wetlands = 2 points.
Elliot and Hall or Environmental Center Identified = 3

Percent Native Forest

10 - 30% = 1 point.
40 - 60% = 2 points.
70% + = 3 points.

Streams were classified as follows:

Outstanding = 6 or more points
Substantial = 4-5 points
Not classified = 3 or fewer.

Other streams were reviewed for inclusion to ensure that there were no obvious mistakes or inadequacies in the database. No streams were added or subtracted from the computer-generated listing.

Results

Inventory

Riparian information is provided for all streams (Table 28) and summarized (Table 21). Information on rare plants is relatively incomplete. This reflects a general problem, which is now being addressed by the Hawaii Heritage Program Database and other efforts. As a general rule, the larger, well-known streams have more complete and longer-term records.

Table 21 Number of Streams with Riparian Information.

Island	T&E Birds	Recovery Habitat	Rare Plants	Protected Part	Protected All	Palustrine Wetlands	Detrimental 1 or fewer
Kauai	38	9	15	7	0	33	23
Oahu	37	10	14	3	0	44	9
Molokai	11	0	5	14	8	12	2
Maui	14	1	9	20	1	39	50
Hawaii	19	4	11	14	1	70	111

Threatened and endangered birds Eighteen species of threatened and endangered birds are associated with streams (Table 22): Kauai - 10 species on 38 streams; Oahu - 4 species on 37 streams; Molokai - 2 species on 11 streams; Maui - 7 species on 14 streams; and Hawaii - 5 species on 19 streams. Four of these species are water birds. One, the puaiohi, is a forest bird, the only two nests of which ever recorded were along stream banks. The remainder are forest birds whose habitat includes streams but the degree of relationship is unknown. One hundred and nineteen streams have threatened and endangered birds within their riparian zone (Table 26). There are four or more birds on 22 streams—2/3 of which are on Kauai. Only one stream, Waimea, Kauai, has nine threatened and endangered birds. One stream has six, seven streams have five, 13 streams have four, 35 have three, 29 have two, and 33 have one. There is no correlation found between length of stream and the number of rare threatened and endangered birds nor is there any relationship between the extent of native forest and number of stream-related forest bird species.

Table 22 Threatened and Endangered Stream-Related Birds

Scientific name	Common name
Fulica americana alai	Hawaiian coot
Gallinula chloropus sandvicensis	Hawaiian Gallinule
Hemignathus parvus	Anianiau
Hemignathus lucidus	Nukupuu
Hemignathus munroi	Akiapolaau
Himantopus mexicanus knudseni	Hawaiian stilt
Anas wyvilliana	Koloa, Hawaiian duck
Loxops coccineus	Akepa
Melamprosops phaeosoma	Poouli
Moho braccatus	Kauai oo
Myadestes lanaiensis	Olomao
Myadestes myadestinus	Kamao
Myadestes palmeri	Puaiohi
Oreomystis bairdi	Kauai Creeper
Oreomystis mana	Hawaii Creeper
Palmeria dolei	Crested Honeycreeper
Pseudonestor xanthophrys	Maui parrotbill
Psittirostra psittacea	Ou

Recovery habitat

Twenty-four perennial streams have waterbird recovery habitat associated with the stream (Table 27): Kauai has nine streams (37%), Oahu ten (42%), Hawaii four (17%), Maui one (4%), and Molokai.

Rare, threatened and endangered plants None of the currently listed threatened and endangered plants are associated with perennial streams.

There are 180 taxa of rare vascular plants associated with streams in Hawaii (Table 30). Kauai has 48 species associated with 21 streams, Oahu 37 species on 21 streams, Molokai 18 species on 18 streams, Maui 25 species on 13 streams, and Hawaii 11 species on 13 streams. Most of the species (105) are found only on one island, 21 on two islands, three on three islands, and one on five islands. None of these species are federally listed.

Twelve streams have four or more rare plants within their riparian zone (six streams on Kauai, two on Oahu, one on Molokai and three on Maui). Waimea system on Kauai has 17 rare plants. There is no correlation between length of stream and the number of rare plants.

Rare communities

Only one of the 18 natural Hawaiian communities classified by the Hawaii Heritage Program that are associated with streams is considered rare, and that community is the Kauai diverse lowland mesic forest. Three examples of this forest are along Kalalau, Milolii, and Waimea streams.

Protected areas A total of 61 streams flow through federal, state or privately protected areas, at least in part: seven on Kauai; four on Oahu; 14 on Molokai; 22 on Maui; and, 13 on Hawaii. Only 13 streams (3 percent of total assessed) are protected along their entirety: Waimanu, Hawaii; Oheo, Maui; nine on Molokai's northshore; and two on Kauai's Na Pali coast.

Wetlands There are 198 streams with associated palustrine wetlands (USFWS 1978): 33 on Kauai; 44 on Oahu; 12 on Molokai; 39 on Maui; and, 70 on Hawaii. Elliott & Hall (1977) list 29: 8 on Kauai, 19 on Oahu and one each on Maui, and Hawaii. The Environmental Center currently lists 18 on Oahu. There are some inconsistencies between the various evaluations which are dependent on different criteria.

Native Forest No perennial stream has native forest along its entire length (Table 23). There is an apparent correlation between the degree of urbanization/agricultural development on an island and the degradation of forest around the streams.

Table 23 Number of streams with Native Forest (percent)

Percentage	Kauai	Oahu	Molokai	Maui	Hawaii
100	0	0	0	0	0
90	0	0	1	0	0
80	0	0	3	3	1
70	0	0	2	5	2
60	1	0	3	2	10
50	2	0	1	4	10
40	4	2	0	4	1
30	11	1	6	6	11
20	7	1	7	11	14
10	12	13	10	13	19
0	30	40	8	31	65

Detrimental organisms

All of Hawaii's perennial streams have detrimental organisms associated with them (Table 24).

Table 24 Number of streams with Detrimental Organisms

Island	Number of detrimental organisms						
	6	5	4	3	2	1	0
Kauai	0	1	2	17	18	23	0
Oahu	0	0	21	14	7	9	0
Molokai	0	6	6	21	0	2	0
Maui	0	0	0	19	29	42	0
Hawaii	1	3	6	0	13	111	0
Total	1	4	35	61	67	187	0

Assessment

Thirty streams have outstanding riparian resources, 65 substantial and the remainder are left unclassified (Table 28, 29). Of the 30 streams classified outstanding:

Twelve have four or more threatened and endangered birds, 26 have threatened and endangered birds;

Six have four or more rare plants, 12 have rare plants;

Six have 70% or more native forest, 16 have 40 % or more native forest;

Fifteen have Recovery Habitat;

Nineteen are protected, four of them along their total length;

All have pigs, eight have other detrimental animals, and 23 have detrimental plants associated with the stream in some part of its course.

Table 25 Island Distribution of Ranked Streams

Rank	Island				
	Kauai	Oahu	Molokai	Maui	Hawaii
Outstanding	8	6	2	9	5
Substantial	18	13	11	10	13
Unclassified	35	38	23	71	114

Discussion

The absence of information on watershed quality in Hawaii made consideration of this important resource in the riparian assessment of streams very difficult. An evaluation of Hawaii's watersheds is considered to be a top priority research need. Other problems include significant lack of data for certain areas; data collected at widely different times, some of it more than 15 years old; inconsistencies in the reporting of information at different times and from different areas, etc., all of which result in a very tenuous assessment.

A number of approaches to assessing riparian resources were made. The objective was to include as many inventoried elements in the assessment as possible. Outstanding riparian resources were identified primarily on the presence of rare species or significant habitats. The chosen assessment included almost all elements inventoried but ranked each element so that there was a relative equality in the scoring for each element. Detrimental organisms, though included in the inventory, were not used in the final assessment to avoid excluding streams with significant resources that might otherwise be penalized.

It could be argued that the use of indirect measurements would result in a somewhat inaccurate ranking. The fact that the committee felt there was no need to add or subtract from the computer-generated listing indicates that the final assessment agreed well with expert opinion.

Limitations

Rare, threatened and endangered communities and species. These communities and species present four problems when used for assessment purposes. First, the communities and/or species may be confined to a small area of a stream otherwise dominated by alien influences. Second, some species, e.g., tree species, can remain for a long time in a sea of aliens. Third, our knowledge of the distribution and condition of these rare riparian resources is inconsistent and incomplete for many streams. Fourth, threatened and endangered species have a legal definition and status. The processing of the proposed lists of species has been very slow so very few have been accorded this legal status. The provisional lists were based on the best assessment of specialists at that time. It is only recently that systematic evaluations have been conducted by The Nature Conservancy of Hawaii, U.S. Fish & Wildlife Service, etc., but even these have not covered the whole state. The consolidated list is incomplete but it is the best so far.

Wetlands. Wetlands were enumerated only if they were associated with a stream. There was no determination of condition.

Detrimental organisms. The data used in this evaluation are the presence or absence of alien herbivorous animals and three plant species. Mere presence does not necessarily mean that these organisms have a negative impact. However, there is a potential for significant damage. Conversely, there are some riparian resources that have been devastated by alien organisms, e.g., East Molokai. The evaluation presupposes that the degree of potential impact is directly related to the number of detrimental species present. Ideally, the assessment would consider the size and extent of the population of each organism.

Native forest. There is no statewide vegetation map that delimits native vs. alien vegetation. Supplementing the Hawaii Forest Bird data with personal opinions of informed individuals presents problems of consistency. The data from Hawaii, Maui and Molokai are reliable. The data from Oahu and some from Kauai information are not as rigorous or consistent.

Initially, only the main stream was measured. It was assumed that since it was the longest stretch of the stream and penetrated further into the center of the island, it would probably pass through as much native forest as any other part of the stream. In certain cases, this may not be true. Measurements were made on topographic quad maps so where there are steep gradients the linear measurement is not an accurate measure of the actual length. A final problem was the interpretation of native vs. alien forest, particularly where there were mixtures of the two types.

Special protected areas. Very few watersheds are protected completely. The fact that part of a stream is in a protected area is no guarantee that the resources will be protected. However, the fact that part of a stream is protected can sometimes influence plans for development.

Other Considerations

Biological threats, both plants and animals, are pervasive. There is no correlation between the number of species of detrimental organisms and the degradation of the watershed. Habitat destruction is related to the number of any particular species present and the combination of species. For example, the almost total destruction of the forest on East Molokai was effected by feral pigs and axis deer. Any assessment of Hawaii's watershed must take these species into account.

Association of rare birds and plants. Threatened and endangered birds generally do not occur on the same stream as rare plants (Table 26). This result was somewhat surprising because one of the committee's earlier assumptions had been that threatened and endangered species would be associated with the least disturbed native habitat. It would follow that the habitat would be equally favorable to birds and plants.

Table 26 Distribution of Threatened or Endangered Birds, and Rare Plants

ISLAND	NUMBER OF STREAMS			
	Birds	Plants	Both	Neither
Kauai	34	9	6	13
Oahu	30	7	7	13
Molokai	10	4	1	21
Maui	12	7	2	69
Hawaii	17	9	2	106

Recovery habitat/Protected areas. There is an inverse relationship between islands that have the largest number of streams with threatened and endangered species recovery habitat (Oahu and Kauai) and those where the streams are protected by various agencies (Molokai, Maui and Hawaii; Table 27). The discrepancy illustrates the fact that streams have not received much attention from conservation managers in the past, an oversight that should be perhaps addressed.

Table 27 Distribution of Recovery Habitat and Protected Areas

ISLAND	NUMBER OF STREAMS	
	Recovery habitat	Protected areas
Kauai	16	7
Oahu	22	5
Molokai	1	14
Maui	1	22
Hawaii	4	15

Future Actions

A statewide evaluation of the condition of watersheds/forest reserves should include a number of elements: the status of vegetation (e.g., cover, structure, species diversity, percentage native forest); alien disturbance factors (e.g., feral animal activity, stream-associated alien plants); land use (e.g., zoning, non-point source pollutants, development); geology; geomorphology; soils; and, climate. Sedimentation and stream flow changes should be evaluated and a quantitative statement of watershed and forest reserve status developed.

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Table 28 Riparian Resources

CODE — HSA code; island-hydrographic unit-stream (system)

NAME — Stream name at mouth

DETRMTL

- PLT — Detrimental Plants
  - C California Grass; H Hau
  - M Mangrove
- ANL — Detrimental Animals
  - A Axis Deer; B Black-tailed deer
  - G Goats; M Mouflan
  - P Pigs; S Sheep

%NAT — Percent Native forest

RH — Presence of Recovery Habitat

BRD T&E — Number of Threatened and Endangered Birds

PLT RAR — Number of Rare Plants

WETLAND

- E — Wetlands identified by Environmental Center or Elliott and Hall
- FWS — Wetland identified by the USFWS
  - W Palustrine Wetland
  - W + Over 1/2 square mile of Palustrine wetland

PROTECT

- PT 1 — Streams partially protected due to the presence of a NARS, NPS or preserve.
- TL Y — Streams protected from the headwaters to the sea

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
Kauai											
2-1-01	Awaawapuhi	H	PGB	30			3				
2-1-02	Honopu		G	0		1					
2-1-03	Nakeikionaiwi		G	0							
2-1-04	Kalalau	H	PG	10			7		W		
2-1-05	Pohakuao		G	0			1				
2-1-06	Waiolaa		G	0							
2-1-07	Hanakoa		PGB	10			1				1
2-1-08	Waiahuakua		G	0			2			Y	1
2-1-09	Hoolulu		G	0			4			Y	1
2-1-10	Hanakapiai	H	PGB	40			3		W		1
2-1-11	Maunapuluo		G	0							
2-1-12	Limahuli	H	G	10			6		W +		
2-1-13	Manoa		P	0			1				
2-1-14	Wainiha R.	HC	P	30		6			W +		
2-1-15	Lumahai R.	HC	P	20	2	5		E	W +		
2-1-16	Waikoko		P	0							
2-1-17	Waipa	H	P	0	2	4			W +		
2-1-18	Waioli	HC	P	30		4			W +		
2-1-19	Hanalei R.	HC	P	30	2	5		E	W +		1
2-1-20	Waileia	H	P	0	2			E			
2-1-21	Anini	H	P	0							
2-1-25	Kalihiwai R.	H	P	20		5		E	W		

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
2-1-26	Puukumu		P	0		3			W+		
2-1-27	Unnamed		P	0							
2-1-28	Kilauea	H	P	20		3		E	W+		
2-1-29	Kulihaili		P	0							
2-1-30	E. Waiakalua		P	0		3			W		
2-1-31	Pilaa		P	0							
2-1-32	W. Waipake		P	0							
2-1-33	E. Waipake		P	0							
2-1-34	Moloaa	H	P	0		3			W		
2-1-35	Papaa		P	0		3			W		
2-1-36	Aliomanu		P	0					W		
2-2-01	Anahola	H	P	10		5		E	W		
2-2-02	Kumukumu	H	P	10		1					
2-2-04	Kapaa	H	P	20		5			W		
2-2-05	Moikeha Canal		P	0		3			W		
2-2-06	Waikaea Canal	H	P	0		4			W+		
2-2-08s	Wailua R. System	H	P	10	2	5			W+		
2-2-10	Kawailoa		P	0		1					
2-2-12	Hanamaulu	H	P	10		4			W		
2-2-13	Nawiliwili	HC	P	10		3			W		
2-2-14	Puali	HC	P	10		3			W		
2-2-15	Huleia	HC	P	10	2	4		E	W+		1
2-3-01	Kipu Kai		P	0		4		E			
2-3-02	Waikomo	H	P	10	2	3			W		
2-3-04	Lawai	HC	P	20		3			W		
2-3-06	Wahiawa	HC	P	30		3	3		W		
2-3-07	Hanapepe	HC	P	30		4	1		W+		
2-4-01	Mahinauli	HC	P	20		3			W		
2-4-02	Aakukui	HC	P	10		3			W		
2-4-03	Waipao	HC	P	30		3			W		
2-4-04s	Waimea R. System	HC	PGB	20		9	17		W+		
2-5-06	Kinekine Ditch			0	2	3					
2-5-07	Kaawaloa		PB	0	2	3					
2-5-08	Nahomalu		PB	10	2	3					
2-5-09	Kaulaula		PB	30					W		
2-5-10	Haeleele		PB	30			2		W		
2-5-13	Kauhao		PB	40		1					
2-5-15	Milolii	H	PB	60		1	6				
2-5-16	Nualolo	H	PB	50		1	4		W		1

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
				Oahu							
3-1-03	Paumalu		P	0			1		W		
3-1-04	Kawela		P	0					W		
3-1-05	Oio		P	0		3			W		
3-1-06	Malaekahana	MHC	P	0		2			W+		
3-1-07	Kahawainui	MHC	P	10		2			W		
3-1-08	Wailele Gl.	MHC	P	10		2			W		
3-1-09	Koloa Gl.	MHC	P	10		2	1		W		
3-1-10	Kaipapau	MHC	P	20		2			W		
3-1-11	Maakua	MHC	P	10			1				
3-1-13	Kaluanui	MHC	P	40		2		E	W+		
3-1-16	Punaluu	MHC	P	10		3		E	W+		
3-1-18	Kahana	MHC	P	10	2	3		E	W+		
3-1-19	Kaaawa	MHC	P	0		2		E	W+		
3-1-20	Makaua		P	0				E			
3-1-21	Unnamed		P	0							
3-2-01	Hakipuu	MHC	P	0		2		E	W		
3-2-02	Waikane	MHC	P	0		2		E	W		
3-2-03	Waianu	MHC	P	0		2			W		
3-2-04	Waiahole	MHC	P	0		2	1	E	W		
3-2-05	Kaalaea	MHC	P	0							
3-2-07s	Kahaluu R. System	MHC	P	0		2		E	W		
3-2-08	Heeia	MHC	P	0	2	4		E	W+		
3-2-09	Keaahala	MHC	P	0		3		E	W		
3-2-10	Kaneohe	MHC	P	0	2	4			W		
3-2-11	Kawa	MHC	P	0				E			
3-2-13	Kawainui/ Maunawili	MCH	P	0	2	4		E	W+		
3-2-14	Kaelepulu Canal	M	P	0		4		E	W		
3-2-15	Waimanalo	CM	P	0	2	3			W		
3-3-03	Kuliouou	MH	P	0		1			W		1
3-3-04	Niu	MH	P	0			1		W		
3-3-05	Wailupe	MH	P	10			2		W		
3-3-06	Waialaenui		P	10			1		W		
3-3-07s	Ala Wai C. System	MH	P	10		1			W		
3-3-09	Nuuanu	M	P	0	2	1			W		
3-3-10	Kapalama	M	P	0		1					
3-3-11	Kalihi	HM	P	0		1			W		
3-3-12	Moanalua	HM	P	0							
3-4-02	Halawa	MCH	P	10				E	W		
3-4-03	Aiea	M	P	0				E	W		
3-4-04	Kalauao	MCH	P	10				E	W		

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
3-4-05	Waimalu	MCH	P	10				E	W		
3-4-06	Waiawa	MCH	P	10		2			W		
3-4-10	Waikele	M	PG	0	2	2	7		W		
3-4-11	Honouliuli	M	P	0		2	1		W		1
3-5-01	Nanakuli	H	P	0					W		
3-5-02	Ulehawa		P	0							
3-5-04	Mailiili	H	PG	0			1		W		
3-5-05	Kaupuni	H	PG	0					W+		
3-5-07	Makaha	H	PG	0		3			W		
3-5-08	Makua		PG	0			2		W		
3-6-03	Unnamed		P	0		2			W		
3-6-04	Makaleha	HC	PG	30	2	3	6		W		1
3-6-06s	Kiikii System	HC	PG	30		2	2		W		1
3-6-07s	Paukauila System	HC	P	40		2			W		
3-6-08s	Anahulu System	HC	P	30		3	1		W		
3-6-09	Loko Ea			0	2	2		E	W+		
3-6-10	Waimea R.	HC	P	10	2	1		E	W		
Molokai											
4-1-01	Waihanau		PAG	10					W	Y	1
4-1-02	Waialeia		PAG	10						Y	1
4-1-03	Waikolu	H	PAG	30			2			Y	1
4-1-04	Wainene		PAG	70			3			Y	1
4-1-05	Anapuhi		PAG	60			3			Y	1
4-1-06	Waiohookalo	HC	PAG	50			3			Y	1
4-1-07	Keawanui		PAG	0						Y	1
4-1-08	Kailiili		PAG	0						Y	1
4-1-09	Pelekunu	HC	PAG	10		1			W+	Y	1
4-1-10	Waipu		PAG	70							1
4-1-11	Haloku		PAG	60							1
4-1-12	Oloupena		PAG	80							1
4-1-13	Puukaoku		PAG	80							1
4-1-14	Wailele		PAG	90							1
4-1-15	Wailau	HC	PAG	10					W+		
4-1-17	Waiahookalo		PAG	60							
4-1-18	Kahiwa		PAG	50							
4-1-19	Kawainui	HC	PAG	80							
4-1-20	Pipiwai		PAG	0							
4-1-21	Halawa	HC	PAG	0		1			W+		
4-1-22	Hakaaano			0							
4-2-01	Pohakupili	M	PA	0							
4-2-02	Honoulimaloo	M	PA	0							
4-2-03	Honouliwai	M	PA	10		1			W		

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
4-2-04	Waialua	MH	PA	10							
4-2-05	Kainalu	MH	PA	20		1			W		
4-2-06	Honomuni	M	PA	20		1			W+		
4-2-08	Mapulehu	MH	PA	10		1			W		
4-2-09	Kaluaaha	M	PA	20							
4-2-10	Kahananui	MH	PA	20							
4-2-11	Manawai	M	PA	20		1					
4-2-12	Ohia	M	PA	20		2			W		
4-2-13	Wawaia	MH	PAG	10		2			W		
4-2-14	Kamalo	MH	PAG	10		2			W+		
4-2-15	Kawela	M	PAG	10		1	4		W		
4-2-16	Papio			0							
Maui											
6-1-01	Ukumehame		P	20					W		
6-1-02	Olowalu		P	30					W		
6-1-03	Launiupoku		P	10					W		
6-1-04	Kauaula		P	30					W		
6-1-05	Kahoma		P	50			4		W		1
6-1-06	Wahikuli		P	20							
6-1-07	Honokowai		P	50			4		W		1
6-1-08	Kahana		P	50					W		
6-1-09	Honokahua	HC	P	30							
6-1-10	Honolua		P	30			1				
6-1-11	Honokohau	HC	P	60			1		W		
6-2-01	Poelua		P	0							1
6-2-02	Honanana		P	20					W		1
6-2-03	Kahakuloa	HC	P	30			1		W		1
6-2-05	Waiolai	HC	P	10							
6-2-06	Makamakaole	HC	P	10			1				1
6-2-07	Waihee R.	HC	P	30					W		
6-2-08	Waiehu	HC	P	20					W		
6-2-09	Iao	HC	P	20			7		W+		
6-2-10	Waikapu		P	30	2	2	1	E	W+		
6-3-01	Maliko		P	30					W		
6-3-02	Kuiaha		P	0					W		
6-3-03	Kaupakulua		P	0					W		
6-3-04	Manawaiiao		P	0							
6-3-05	Uaoa		P	0					W		
6-3-07	Kakipi	H	P	0					W+		
6-3-08	Honopou	H	P	0					W		
6-3-09	Hoolawa	H	P	0					W		
6-3-10	Waipio	H	P	0					W		

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
6-3-11	Hanehoi		P	0							
6-3-12	Hoalua		P	0							
6-3-13	Hanawana		P	0							
6-3-14	Kailua	H	P	20					W		
6-3-15	Nailiilihaele	H	P	20					W+		
6-4-01	Oopuola	H	P	0							
6-4-02	Kaaiea	H	P	10							
6-4-03	Kolea		P	0							
6-4-04	Waikamoi	H	P	30		3			W		1
6-4-06	Puohokamoa	H	P	40					W		1
6-4-07	Haipuaena		P	0					W		1
6-4-08	Punalau	CH	P	30		2					
6-4-09	Honomanu	CH	P	50		3			W+		1
6-4-10	Nuaailua		P	10					W		1
6-4-11	Piinaau	CH	P	60		3			W+		1
6-4-12	Ohia		P	0							
6-4-13	Waiokamilo	H	P	40							
6-4-14	Wailuanui	H	P	70							1
6-4-15	W. Wailuaiki		P	70		3					1
6-4-16	E. Wailuaiki		P	70		3			W		1
6-4-17	Kopiliula	H	P	80		3			W		1
6-4-18	Waiohue Gl.		P	20							
6-4-19	Paakea		P	20							
6-4-20	Waiaaka		P	10							
6-4-21	Kapaula		P	30							1
6-4-22	Hanawi	H	P	80		5	1				1
6-4-23	Makapipi	H	P	50							1
6-4-24	Kuhiwa		P	80		2					1
6-4-25	Waihole		P	20							
6-4-26	Manawaikeae		P	10							
6-4-27	Kahawaihapapa		P	0							
6-4-28	Keaaiki		P	0							
6-4-29	Waioni		P	20							
6-4-30	Lanikele		P	10							
6-4-31	Heleleikeoha		P	40		1					1
6-4-32	Kawakoe	H	P	30							
6-4-33	Ulaino	H	P	20							
6-4-34	Kawaipapa	H	P	30					W		
6-4-36	Unnamed			0							
6-5-01	Moomoonui		P	10					W		
6-5-02	Haneoo		P	0							
6-5-03	Kapia		P	10					W		
6-5-04	Waiohonu	H	P	40		2			W		
6-5-05	Papaahawahawa		P	0							

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
6-5-06	Alaalaula		P	0							
6-5-07	Wailua		P	0							
6-5-08	Honolewa		P	0							
6-5-09	Waieli		P	0							
6-5-10	Kakiweka		P	0							
6-5-11	Hahalawe		P	0							
6-5-12	Puaaluu		P	0							
6-5-13	Oheo	H	P	70		4			W	Y	
6-5-15	Koukouai		PG	70							
6-5-16	Opelu		PG	0							
6-5-17	Kukuiula		PG	0							
6-5-18	Kaapahu		PG	0							
6-5-19	Lelekea		PG	0							
6-5-20	Alelele		PG	20					W		
6-5-21	Kalepa		PG	10					W		
6-5-22	Nuanuaaloa		PG	10		1					
6-5-24	Manawainui		PG	10							
	Hawaii										
8-1-03	Kumakua		P	0					W		
8-1-06	Hanaula		P	0					W		
8-1-07	Hapahapai		P	0		1			W		
8-1-08	Pali Akamoa		P	0							
8-1-09	Wainaia		P	0					W		
8-1-10	Unnamed		P	0					W		
8-1-11	Halawa		P	50					W		
8-1-12	Aamakao		P	50					W		
8-1-13	Niulii		P	30					W		
8-1-14	Waikama		P	50					W		
8-1-15	Pololu		P	60	2	1			W+		
8-1-16	Honokane Nui		P	60					W+		1
8-1-17	Honokane Iki		P	50					W		
8-1-18	Kalele Gl.		P	0							
8-1-19	Waipahi		P	10					W		
8-1-20	Honokea		P	60					W		
8-1-21	Kailikaula		P	40							
8-1-22	Honopue		P	60					W		
8-1-23	Kolealiilii		P	20							
8-1-24	Ohiahuea		P	70					W		
8-1-25	Nakooko		P	60							
8-1-26	Waiapuka		P	20					W		
8-1-27	Waikaloa		P	60					W		
8-1-28	Waimaile		P	10							

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
8-1-29	Kukui		P	20							
8-1-30	Paopao		P	10					W		
8-1-31	Waiaalala		P	10							
8-1-32	Punalulu		P	0					W		
8-1-33	Kaimu		P	50			1		W		1
8-1-34	Pae		P	50			1				1
8-1-35	Waimanu		P	50	2		1	E	W	Y	1
8-1-36	Pukoa		P	10							
8-1-37	Manuwaikaalio		P	10							
8-1-38	Naluea		P	10							
8-1-39	Kahoopuu		P	20							
8-1-42	Waipahoehoe		P	30							1
8-1-44	Waipio/Wailoa		P	60	2	1	1		W+		1
8-1-45	Lalakea		P	10		1			W+		
8-1-46	Kaluahine Falls		P	0							
8-1-47	Waiulili		P	0		1					
8-1-49	Waipunahoe		MSGP	0							
8-1-50	Waialeale		P	0							
8-1-51	Waikoloa		P	0							
8-1-52	Kapulena		P	0							
8-1-53	Kawaikalia		P	0					W		
8-1-54	Malanahae		P	0							
8-1-61	Nienie		P	0					W		
8-1-62	Papuaa		P	0							
8-1-65	Kahaupu		P	10					W		
8-1-66	Kahawailiili		MSGP	10					W		
8-1-67	Keahua		P	0							
8-1-68	Kalopa		MSGP	10					W		
8-1-69	Waikaalulu		P	20					W		
8-1-70	Kukuilamalamahii		P	10					W		
8-1-71	Alilipali		P	0					W		
8-1-73	Kaumoali Gl		P	30					W		
8-1-76	Waipunahina		P	30					W		
8-1-77	Waipunalau Gl		P	10					W		
8-1-78	Paauilo		P	0					W		
8-1-79	Aamanu		P	0					W		
8-1-80	Koholalele Gl		MSGP	20					W		
8-1-81	Kalapahapu Gl		P	20					W		
8-1-82	Kukaiau		MSGP	30					W		
8-1-85	Kaala		P	20					W		
8-1-86	Kealakaha		P	30		1					
8-1-88	Kupapaulua		P	20		1			W		
8-1-89	Kaiwiki		P	0							
8-1-90	Kaula		MSGP	30		2			W		

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
8-2-01	Kaohaoha		P	0							
8-2-02	Kaawalii	H	P	20		2	1		W		
8-2-03	Waipunalei		P	0							
8-2-04	Laupahoehoe		P	0			3		W		
8-2-05	Kilau		P	0			3		W		1
8-2-06	Manowaiopae		P	0					W		
8-2-07	Kuwaikahi		P	0							
8-2-08	Kihalani		P	0					W		
8-2-09	Kaiwilahilahi		P	10			2		W		1
8-2-10	Haakoa	H	P	30		1			W		
8-2-11	Pahale		P	20							
8-2-12	Kapehu		P	0					W		
8-2-13	Paeohe		P	0					W		
8-2-14	Maulua		P	0					W		
8-2-16	Pohakupuka		P	20							
8-2-17	Kulanakii		P	0							
8-2-18	Ahole		P	0							
8-2-19	Poupou		P	0							
8-2-20	Manoloa		P	0							
8-2-21	Ninole		P	0							
8-2-22	Kaaheiki		P	0							
8-2-23	Waikolu		P	0							
8-2-24	Waikaumalo	H	P	30			2		W		
8-2-25	Kahuku		P	20							
8-2-26	Waiehu		P	0							
8-2-27	Nanue	H	P	0			1		W		
8-2-28	Opea	H	P	10					W		
8-2-29	Peleau		P	0							
8-2-30	Umauma	H	MSGP	50		2			W		1
8-2-31	Kamaee		P	10							
8-2-32	Hakalau	H	P	60		3			W		1
8-2-33	Kolekole	H	MSGP	60		3					1
8-2-34	Paheehee		P	0					W		
8-2-35	Honomu	H	P	10					W		
8-2-36	Laimi		P	0							
8-2-37	Kapehu		P	0							
8-2-38	Makea		P	0							
8-2-39	Alia		P	0							
8-2-40	Makahanaloa	H	P	0							
8-2-41	Waimaauou	H	P	0							
8-2-42	Waiaama	H	P	10							
8-2-43	Kawainui	H	P	50			1		W		
8-2-44	Onomea		P	0							
8-2-45	Alakahi		P	0							

CODE	NAME	DETRMTL		%NAT	RH	BRD T&E	PLT RAR	WETLAND		PROTECT	
		PLT	ANL					E	FWS	TL	PT
8-2-46	Hanawi		P	30					W		
8-2-47	Kalaoa		P	0							
8-2-48	Aleamai		P	0							
8-2-49	Kaieie		P	0					W		
8-2-50	Puuokalepa		P	0					W		
8-2-51	Kaapoko		P	0							
8-2-52	Papaikou		P	0							
8-2-53	Kapue	H	MSGP	70		3					1
8-2-54	Pahoehoe		P	50							
8-2-55	Paukaa		P	0							
8-2-56	Honolii	H	P	80		3			W		1
8-2-57	Maili		P	0					W		
8-2-59	Pukihae		P	10					W		
8-2-60	Wailuku R.	CH	MSGP	60		4			W		1
8-2-61	Wailoa R.		P	0	2	1					
8-2-62	Kaahakina			0							
8-4-02	Waiaha		P	0		1					
8-5-01	Haloa		P	0							
8-5-02	Lamimaumau		P	0							
8-5-03	Waikoloa		P	0					W		

Table 29 Outstanding and Substantial Riparian Resources.

OUTSTANDING RIPARIAN RESOURCE STREAMS

Kauai
2-1-15 Lumahai R.
2-1-17 Waipa
2-1-19 Hanalei R.
2-2-08s Wailua R. System
2-2-15 Huleia
2-3-07 Hanapepe
2-4-04s Waimea R. System
2-5-16 Nualolo

Oahu
3-1-18 Kahana
3-2-08 Heeia
3-2-13 Kawainui/Maunawili
3-4-10 Waikele
3-6-04 Makaleha
3-6-10 Waimea R.

Molokai
4-1-04 Wainene
4-1-09 Pelekunu

Maui
6-1-05 Kahoma
6-1-07 Honokowai
6-2-10 Waikapu
6-4-09 Honomanu
6-4-11 Piinaau
6-4-16 E. Wailuaiki
6-4-17 Kopiliula
6-4-22 Hanawi
6-5-13 Oheo

Hawaii
8-1-15 Pololu
8-1-35 Waimanu
8-1-44 Waipio/Wailoa
8-2-56 Honolii
8-2-60 Wailuku R.

SUBSTANTIAL RIPARIAN RESOURCE STREAMS

Kauai
2-1-04 Kalalau
2-1-09 Hoolulu
2-1-10 Hanakapiai
2-1-12 Limahuli
2-1-14 Wainiha
2-1-18 Waioli
2-1-20 Waileia
2-1-25 Kalihiwai
2-1-28 Kilauea
2-2-01 Anahola
2-2-04 Kapaa
2-2-06 Waikaea Canal
2-2-12 Hanamaulu
2-3-01 Kipu Kai
2-3-02 Waikomo
2-3-06 Wahiawa
2-5-08 Nahomalu
2-5-15 Milolii

Oahu
3-1-09 Koloa Gl.
3-1-13 Kaluanui
3-1-16 Punaluu
3-2-04 Waiahole
3-2-10 Kaneohe
3-2-14 Kaelepulu Canal
3-2-15 Waimanalo
3-3-09 Nuuanu
3-4-11 Honouliuli
3-6-06s Kiikii System
3-6-07s Paukauila System
3-6-08s Anahulu System
3-6-09 Loko Ea

Molokai
4-1-01 Waihanau
4-1-03 Waikolu
4-1-05 Anapuhi
4-1-06 Waiohookalo
4-1-10 Waipu
4-1-12 Oloupena
4-1-13 Puukaoku
4-1-14 Wailele
4-2-06 Honomuni
4-2-14 Kamalo
4-2-15 Kawela

Maui
6-1-11 Honokohau
6-2-03 Kahakuloa
6-2-09 Iao
6-4-04 Waikamoi
6-4-06 Puohokamoa
6-4-14 Wailuanui
6-4-15 W. Wailuaiki
6-4-24 Kuhiwa
6-4-31 Heleleikeoha
6-5-04 Waiohonu

Hawaii
8-1-16 Honokane Nui
8-1-24 Ohiahuea
8-1-33 Kaimu
8-1-34 Pae
8-1-45 Lalakea
8-2-02 Kaawalii
8-2-09 Kaiwilahilahi
8-2-24 Waikaumalo
8-2-30 Umauma
8-2-32 Hakalau
8-2-33 Kolekole
8-2-43 Kawainui
8-2-53 Kapue

Table 30 Rare, threatened, and endangered stream-associated plants

Sources: Hawaii Heritage Database
National list of plant species that occur in wetlands (USFWS 1988).

Abutilon sandwicense/Malvaceae
Acacia koaia/Fabaceae
Acaena exigua/Rosaceae
Alectryon macrococcus var. *macrococcus*/Sapindaceae
Alsinidendron lychnoides/Caryophyllaceae
Alsinidendron viscosum/Caryophyllaceae
Argyroxiphium caliginis/Asteraceae
Asplenium schizophyllum/Aspleniaceae
Bidens wiebkei/Asteraceae
Bobea sandwicensis/Rubiaceae
Bonamia menziesii/Convolvulaceae
Brighamia insignis/Campanulaceae
Caesalpinia kavaiensis/Fabaceae
Calamagrostis expansa/Poaceae
Calamagrostis hillebrandii/Poaceae
Canavalia napaliensis/Fabaceae
Cenchrus agrimonioides var. *agrimonioides*/Poaceae
Centaurium sebaeoides/Asteraceae
Chamaesyce herbstii/Euphorbiaceae
Charpentiera densiflora/Amarantuaceae
Cherirodendron dominii/Araliaceae
Clermontia drepanomorpha/Campanulaceae
Clermontia lindseyana/Campanulaceae
Clermontia oblongifolia/Campanulaceae
Colubrina oppositifolia/Rhamnaceae
Cyanea grimesiana ssp. *grimesiana*/Campanulaceae
Cyanea grimesiana ssp. *obatae*/Campanulaceae
Cyanea horrida/Campanulaceae
Cyanea kunthiana/Campanulaceae
Cyanea lobata/Campanulaceae
Cyanea macrostegia/Campanulaceae
Cyanea scabra/Campanulaceae
Cyanea solanacea/Campanulaceae

Cyanea solenocalyx/Campanulaceae
Cyanea superba ssp. *regina*/Campanulaceae
Cyanea tritomantha/Campanulaceae
Cyanea truncata/Campanulaceae
Cyperus trachysanthos/Cyperaceae
Cyrtandra biserrata/Gesneriaceae
Cyrtandra dentata/Gesneriaceae
Cyrtandra filipes/Gesneriaceae
Cyrtandra giffardii/Gesneriaceae
Cyrtandra halawensis/Gesneriaceae
Cyrtandra munroi/Gesneriaceae
Cyrtandra tintinnabula/Gesneriaceae
Cyrtandra viridiflora/Gesneriaceae
Delissea rivularis/Campanulaceae
Delissea subcordata/Campanulaceae
Diellia erecta/Pteridaceae
Diellia falcata/Pteridaceae
Diellia laciniata/Pteridaceae
Dissochondrus biflorus/Poaceae
Dryopteris minuta/Pteridaceae
Dubautia imbricata/Asteraceae
Dubautia knudsenii/Asteraceae
Dubautia microcephala/Asteraceae
Dubautia pauciflorula/Asteraceae
Dubautia plantaginea ssp. *humilis*/Asteraceae
Eugenia koolauensis/Myrtaceae
Euphorbia haeleeleana/Euphorbiaceae
Eurya sandwicensis/Theaceae
Exocarpos luteolus/Santalaceae
Flueggea neowawraea/Euphorbiaceae
Gardenia mannii/Rubiaceae
Gardenia remyi/Rubiaceae
Geranium humile/Geraniaceae
Geranium multiflorum/Geraniaceae
Hedyotis elatior/Rubiaceae
Hedyotis fluviatilis/Rubiaceae
Hedyotis formosa/Rubiaceae
Hedyotis littoralis/Rubiaceae
Hesperomannia arbuscula/Asteraceae
Hesperomannia lydgatei/Asteraceae
Hibiscus brackenridgei ssp. *brackenridgei*/Malvaceae

Hibiscus distans/Malvaceae
Hibiscus kokio ssp. *kokio*/Malvaceae
Hibiscus kokio ssp. *saintjohnianus*/Malvaceae
Hibiscus waimeae ssp. *hannerae*/Malvaceae
Huperzia mannii/Lycopodiaceae
Isodendrion laurifolium/Violaceae
Isodendrion longifolium/Violaceae
Isoetes hawaiiensis/Isoetaceae
Joinvillea ascendens ssp. *ascendens*/Flagellariaceae
Kokia kauaiensis/Malvaceae
Labordia pumila/Loganiaceae
Lagenifera maviensis/Asteraceae
Lepidium serra/Brassicaceae
Lipochaeta fauriei/Asteraceae
Lipochaeta tenuis/Asteraceae
Lobelia dunbarii ssp. *dunbarii*/Campanulaceae
Lobelia hypoleuca/Campanulaceae
Lobelia niihauensis/Campanulaceae
Lobelia oahuensis/Campanulaceae
Lobelia yuccoides/Campanulaceae
Lysimachia daphnoides/Primulaceae
Lysimachia filifolia/Primulaceae
Lysimachia forbesii/Primulaceae
Lysimachia glutinosa/Primulaceae
Lysimachia kalalauensis/Primulaceae
Marsilea villosa/Marsileaceae
Munroidendron racemosum/Araliaceae
Myrsine fosbergii/Myrsinaceae
Myrsine juddii/Myrsinaceae
Myrsine petiolata/Myrsinaceae
Myrsine vaccinioides/Myrsinaceae
Neraudia kauaiensis/Urticaceae
Neraudia melastomifolia/Urticaceae
Nesoluma polynesicum/Sapotaceae
Nothocestrum latifolium/Solanaceae
Nototrichium humile/Amaranthaceae
Panicum napaliense/Poaceae
Pelea cruciata/Rutaceae
Pelea degeneri/Rutaceae
Pelea haleakalae/Rutaceae
Pelea hawaiensis/Rutaceae

Pelea orbicularis/Rutaceae
Pelea reflexa/Rutaceae
Pelea waialealae/Rutaceae
Peucedanum sandwicense/Apiaceae
Phyllostegia floribunda/Lamiaceae
Phyllostegia hirsuta/Lamiaceae
Phyllostegia mannii/Lamiaceae
Phyllostegia mollis/Lamiaceae
Phyllostegia parviflora var. *glabriuscula*/Lamiaceae
Phyllostegia parviflora var. *parviflora*/Lamiaceae
Phyllostegia parviflora var1/Lamiaceae
Phyllostegia stachyoides/Lamiaceae
Phyllostegia vestita/Lamiaceae
Phyllostegia wawrana/Lamiaceae
Pisonia wagneriana/Nyctaginaceae
Pittosporum napaliense/Pittosporaceae
Plantagoprinceps var. *laxiflora*/Plantaginaceae
Plantago princeps var. *longibracteata*/Plantaginaceae
Plantago princeps var. *princeps*/Plantaginaceae
Platanthera holochila/Orchidaceae
Platydesma cornuta var. *cornuta*/Rutaceae
Platydesma cornuta var. *decurrens*/Rutaceae
Platydesma remyi/Rutaceae
Poa mannii/Poaceae
Poa sandvicensis/Poaceae
Poa siphonoglossa/Poaceae
Pritchardia glabrata/Arecaceae
Pritchardia hardyi/Arecaceae
Pritchardia kaalae/Arecaceae
Pritchardia lanigera/Arecaceae
Pritchardia lowreyana/Arecaceae
Pritchardia munroi/Arecaceae
Pritchardia napaliensis/Arecaceae
Pritchardia viscosa/Arecaceae
Psychotria grandiflora/Rubiaceae
Psychotria hobdyi/Rubiaceae
Pteralyxia kauaiensis/Apocynaceae
Pteralyxia macrocarpa/Apocynaceae
Pteris lidgatii/Pteridaceae
Ranunculus mauiensis/Ranunculaceae
Remya kauaiensis/Astesaceae

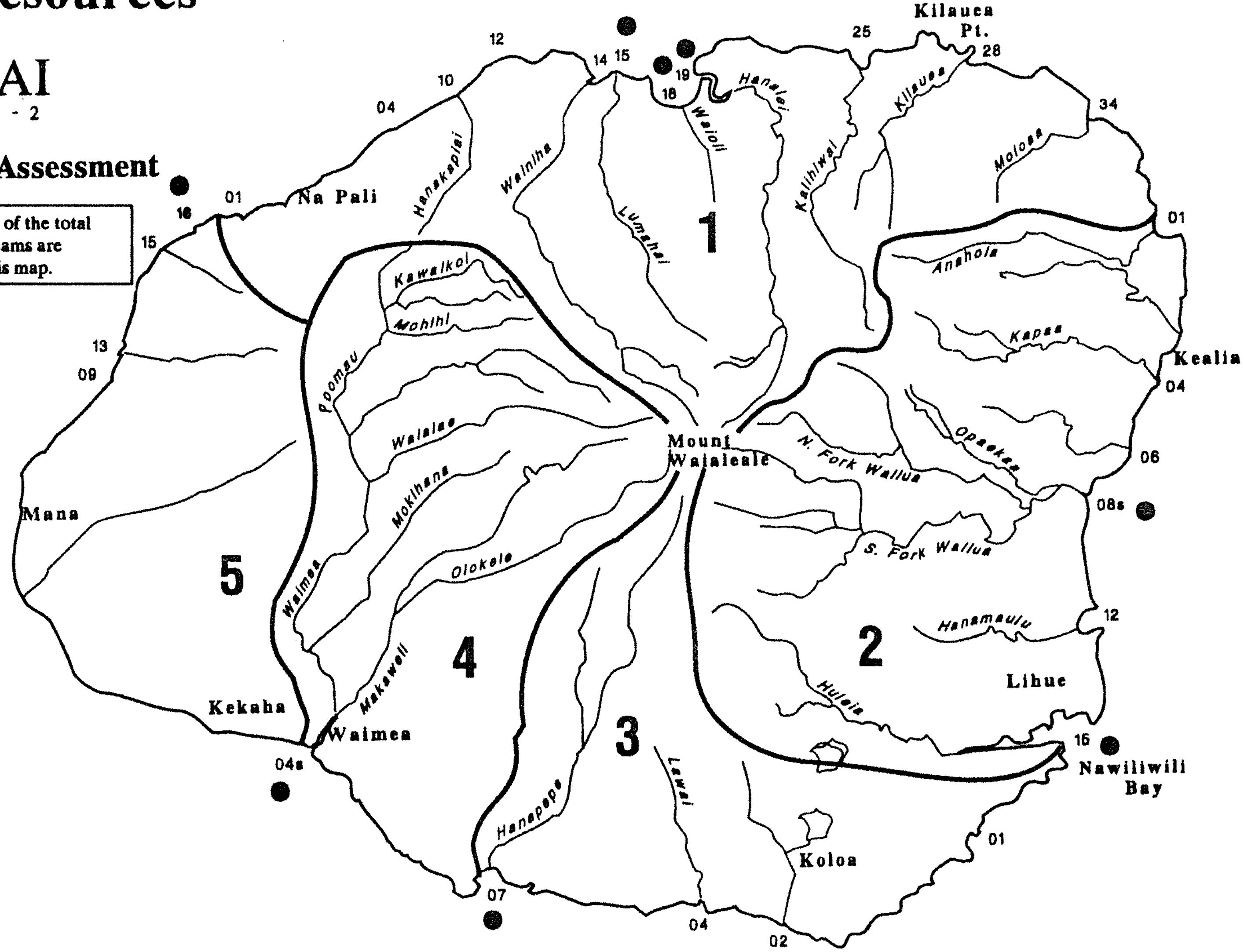
Rollandia purpurellifolia/Campanulaceae
Rollandia st-johnii/Campanulaceae
Sanicula purpurea/Apiaceae
Schiedea globosa/Caryophyllaceae
Schiedea kaalae/Caryophyllaceae
Schiedea membranacea/Caryophyllaceae
Schiedea menziesii/Caryophyllaceae
Sicyos cucumerinus/Cucurbitaceae
Sicyos spa/Cucurbitaceae
Silene lanceolata/Caryophyllaceae
Solanum sandwicense/Solanaceae
Stenogyne macrantha/Lamiaceae
Stenogyne scrophularioides/Lamiaceae
Trematolobelia grandifolia/Campanulaceae
Trisetum inaequale/Poaceae
Urera kaalae/Urticaceae
Vandenboschia draytoniana/Hymenophyllaceae
Viola chamissoniana/Violaceae
Viola helenae/Violaceae
Viola kauaensis var.*wahiawaensis*/Violaceae
Viola oahuensis/Violaceae
Wikstroemia bicornuta/Thymeliaceae
Xylosma crenatum/Flacourtiaceae
Zanthoxylum oahuense/Rutaceae

Map 5
Outstanding Riparian Resources

KAUAI
Island Code - 2

Hawaii Stream Assessment

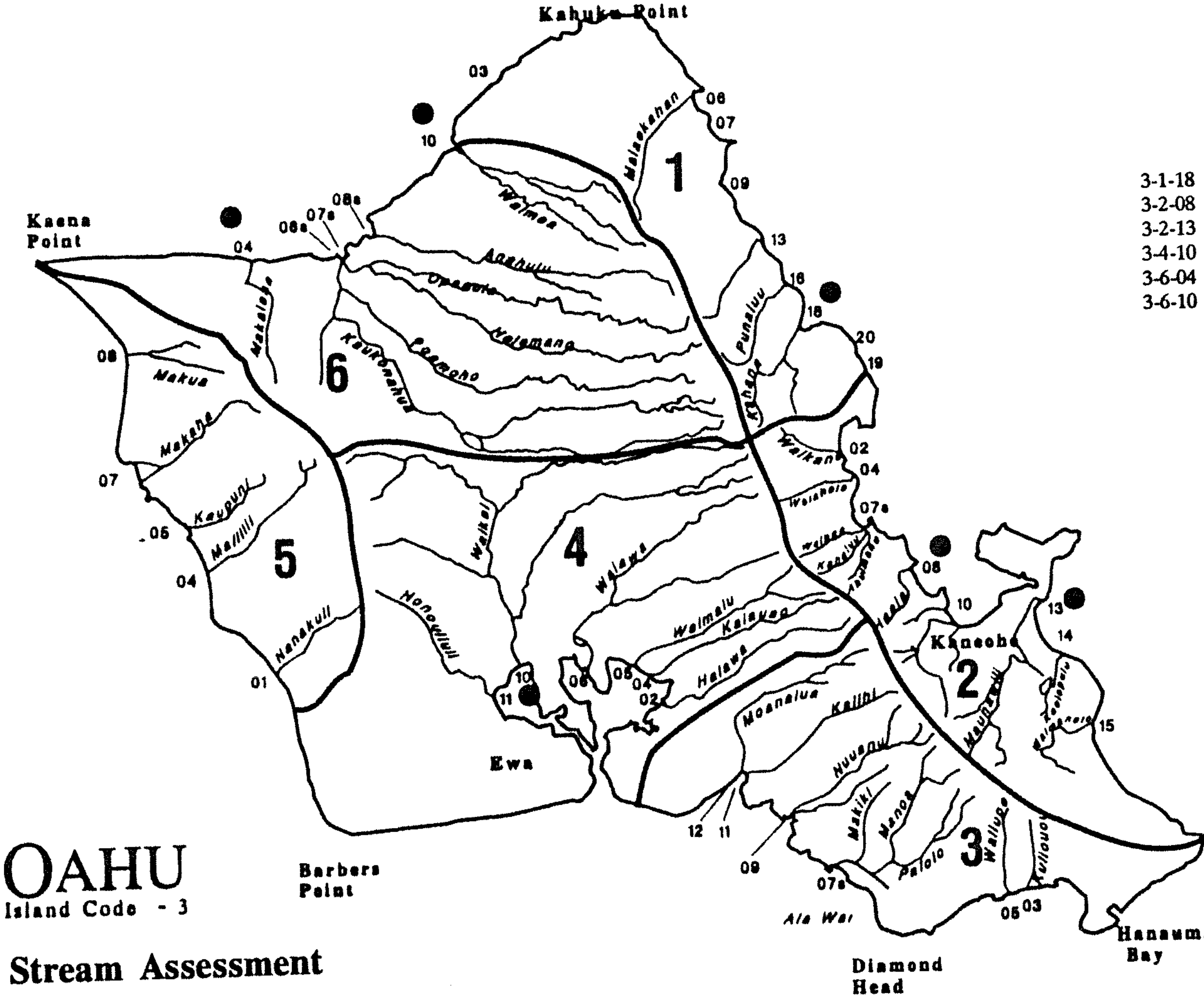
Note:	Only a portion of the total number of streams are depicted on this map.



2-1-15 Lumahai R.
2-1-17 Waipa
2-1-19 Hanalei R.
2-2-08s Wailua S.
2-2-15 Huleia
2-3-07 Hanapepe
2-4-04s Waimea S.
2-5-16 Nualolo

Map 5

Outstanding Riparian Resources



3-1-18 Kahana
3-2-08 Heeia
3-2-13 Kawainui//Maunawili
3-4-10 Waikele
3-6-04 Makaleha
3-6-10 Waimea R.

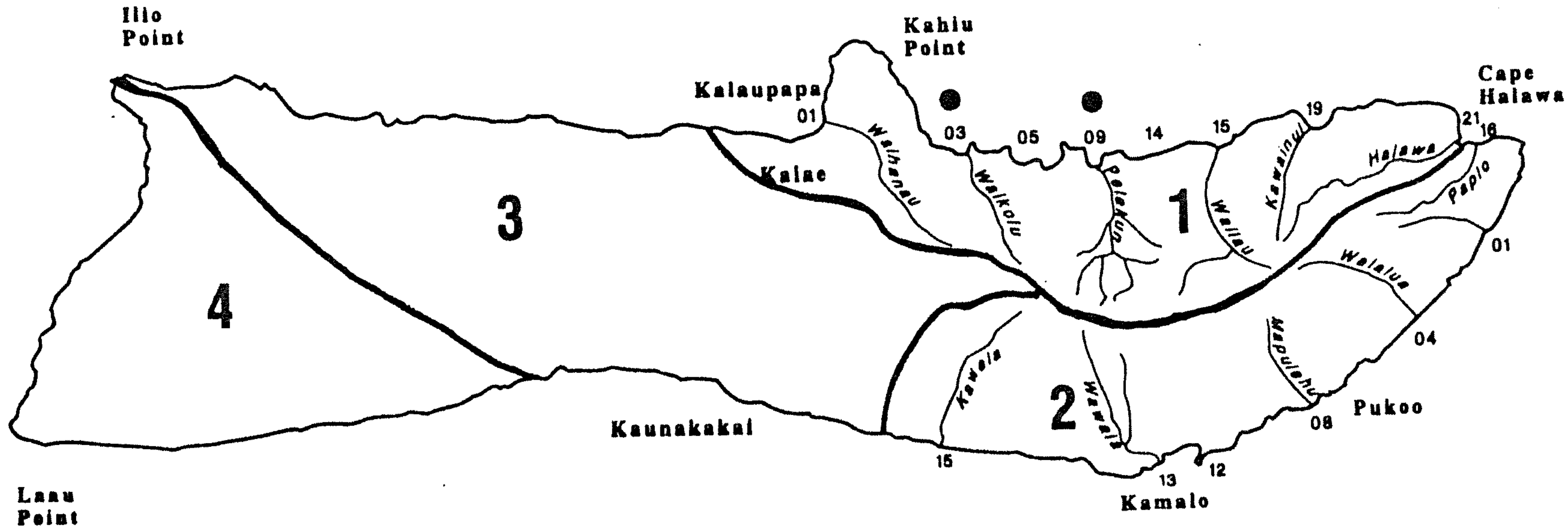
OAHU

Island Code - 3

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 5 Outstanding Riparian Resources



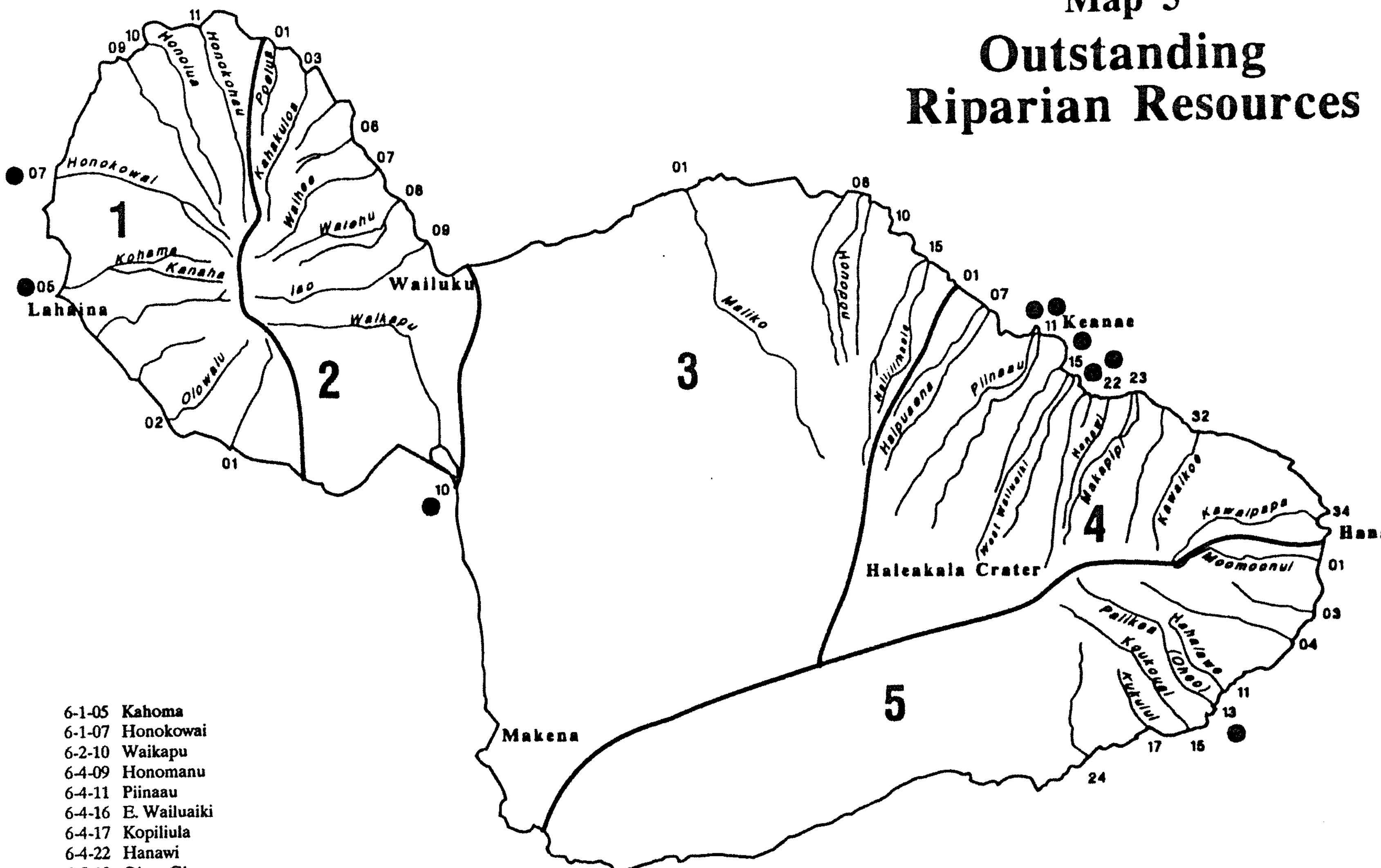
4-1-04 Wainene
4-1-09 Pelekunu

MOLOKAI
Island Code - 4

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 5
Outstanding Riparian Resources



6-1-05 Kahoma
6-1-07 Honokowai
6-2-10 Waikapu
6-4-09 Honomanu
6-4-11 Piinaau
6-4-16 E. Wailuaiki
6-4-17 Kopiliula
6-4-22 Hanawi
6-5-13 Oheo Gl

MAUI
Island Code - 6

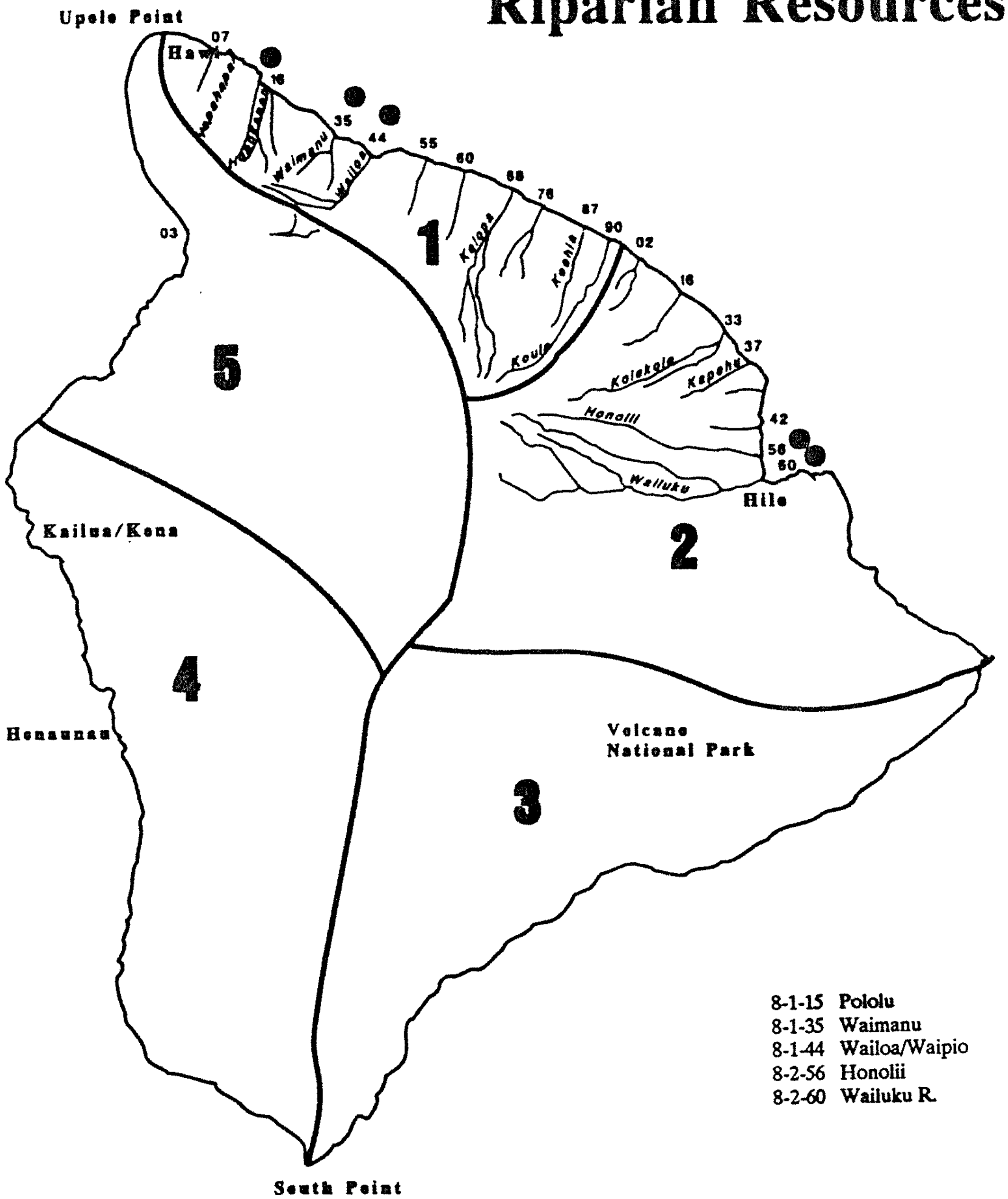
Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

000241

Map 5

Outstanding Riparian Resources



HAWAII

Island Code - 8

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Cultural Resources

Streams have played an important role in prehistoric, historic and modern ways of life in Hawaii. This inventory and assessment focuses on the relationships with surface water which are of historic, architectural, spiritual or aesthetic value. Some of these are easily identifiable, such as bridges or taro lo'i, while others have less tangible historic or mythological associations.

The Cultural Resources Committee, which directed the inventory and assessment, determined that in order to be considered stream-related, a cultural resource had to meet one of the following criteria:

- Changes in stream management would affect the resource.
- The resource was functionally dependent on the stream.
- The resource was in close proximity to the stream.

Cultural resources include prehistoric, historic and modern elements. In Hawaii, prehistoric resources generally refer to those prior to contact with the western world, which was marked by the arrival of Captain Cook in 1778. The prehistoric elements consist primarily of archaeological sites and the probability of uncovering such sites. Elements of historic, or post-contact, resources include sites listed on the State or National Register of Historic Places, historic districts and bridges. Modern cultural resources listed here are sites where taro is grown.

The primary source of information on cultural resources is the Department of Land and Natural Resources. The Historic Preservation Division provided the historic and archaeological data. Location of taro cultivation was collected from the Water Use Certification Program currently being compiled by the DLNR Division of Water and Land Development. Additions and adjustments were made by the committee.

Comprehensive and consistent inventories of historic and modern cultural resources were not available. Some cultural elements, such as legends or events, are subjective and intangible. As such, they do not lend themselves well to inventory or assessment. Criteria for assessment of cultural resources were therefore based exclusively on prehistoric archaeological resources.

Ninety-five streams were judged Outstanding for cultural reasons. Thirty-four of these streams are on Kauai, six on Oahu, 15 on Molokai, nine on Maui and 31 on Hawaii. Three of these streams have more than 100 archaeological sites each.

Background

Prehistoric/Archaeologic Resources

A key to understanding stream-related cultural resources in Hawaii is the realization that in prehistoric and historic times, Hawaiians were as much farmers as they were fishermen, and stream water was crucial to successful farming. Many valley floors in the islands had irrigated taro fields (lo'i) fed by canals ('auwai) from streams, springs, and waterfall ponds. Houses were located on the narrow dry slopes at the base of valley walls and across sand flats and dunes at valley mouths. Burials and dry agricultural areas for tree crops, sweet potatoes, wauke, and the like were also associated with these houses. Some valleys had continuous sites of these types; other, narrower valleys had scattered clusters of sites extending upstream. Many of the larger fertile valleys have large heiaus and residences because they served as residential centers for rulers or high chiefs. These sites are often nearer the shore.

With depopulation in the 1800s and other changes of that century, housing and religious structures and agricultural fields fell into ruin with only the stone and earthen foundations remaining. These sites have been destroyed in some areas over the years with new use of the land – sugarcane cultivation, urbanization, etc. Until the 1970s archaeological documentation of these sites was extremely limited. This changed with the advent of historic preservation law requirements tied to development. Archaeological surveys have accompanied development since the 1970s, and more and more is being learned. Also, a few University of Hawaii and Bishop Museum projects have aided knowledge – e.g., UH Manoa's work in Pololu and the Honokane valleys on Hawaii, and the Bishop Museum's Makaha, Kahana, and Anahulu projects on Oahu and its Halawa project on Molokai. Archaeologists are now better able to predict site patterns in most valleys.

Historic Resources

Historic patterns of settlement tended to duplicate the prehistoric, and thus a close physical relationship with the water was maintained, even if the dependency on riparian cultivation was diminished. For these reasons, Hawaii has several historic districts that might be considered stream related.

Modern Resources

Taro is the primary modern cultural resource which lends itself to inventory. Taro was a staple of the traditional Hawaiian diet. Wetland taro was irrigated from paddy to paddy (lo'i) by gravity flow irrigation systems. This crop is visually distinctive both in its large heart shaped leaf, and in the landscape pattern of the flooded taro lo'i. The early Western voyagers to Hawaii eloquently described the irrigated river valleys as the most compelling feature of the Hawaiian cultivated landscape.

Taro is dependent on a combination of several physical factors, the two most obvious being a water source and agriculturally appropriate land. Extensive taro cultivation provides the modern viewer with a picture of the ancient landscape of Hawaii. Raising taro has several cultural ramifications. As in ancient times, the interdependence of multiple users on the same water source mandates cooperation and controls. The traditional spiritual importance of taro is perpetuated by its growers. The physically demanding cultivation and harvest process, little changed from ancient times, provides experience and understanding of what life must have been like.

Taro cultivation is a contemporary continuation of ancient practices. It helps the modern observer understand the oral, archaeological and written records of the ancient Hawaiian culture. For these reasons, the contemporary cultivation of taro was considered a cultural resource by the HSA Cultural Resources Committee.

Methods

Committee

A committee of experts in the fields of cultural prehistory, history and current Hawaiian practices from the community, state government, and the University of Hawaii was assembled. This group identified inventory elements and assessment criteria.

Cultural Resource Committee

Kiyoshi Ikeda, (chair) UH Manoa Sociology,
Hawaii Historic Preservation Review Board
William Murtagh, UH Manoa Historic Preservation
Ross Cordy, DLNR Historic Preservation
Don Hibbard, DLNR Historic Preservation
Lani Ma'a, Judiciary History Center
Charlie Reppun, taro farmer

Inventory

Data were collected in three general areas: archaeological, historical and modern practices. All archaeological data were compiled by the state Historic Preservation Division and submitted to HSA in final form. Historic resource information was obtained through files and documents housed at the Historic Preservation Division. Taro data was extracted from the November 1989 printout of the Division of Water and Land Development's Water Certification Database and from committee input.

Prehistoric/Archaeological Resources

Several variables were analyzed for each valley. Each is briefly described below.

Survey Coverage. The extent of archaeological survey coverage was analyzed and recorded as complete, partial, very limited and none. Few valleys are completely surveyed. Many have little or no survey coverage.

Predictability. The ability to predict what historic sites might be in unsurveyed areas was scored as high, medium or low predictability or unable to predict. A high score was assigned if archaeologists were able to predict likely site patterns in a valley given historic documents, extensive archaeological surveys in nearby or similar valleys, and/or partial survey coverage. A low score was assigned if archaeologists were unable to predict site patterns in a valley because of a lack of historical or archaeological information. A medium score was assigned to all other cases.

Number of Sites. The actual number of historic sites known in each valley is straightforward yet very time consuming to count. Instead, archaeologists used survey information to estimate the number of sites in each valley. These figures, adequate for this broad-based assessment, are only rough estimates.

Valley Significance as a Whole District. The overall evaluation of each valley's significance was made considering each valley a district. The significance criteria of the National and Hawaii Registers of Historic Places was used. Criterion A applies if the district is significant in addressing broad patterns of prehistory or early history. Criterion B applies if the district is associated with important people (rulers) or deities. Criterion C applies if the district contains excellent examples of site types. Criterion D applies if the district is significant for information contained in its sites. Finally, criterion E applies if the district is culturally significant for traditionally known places or events or for sites such as burials, religious structures, trails, and other culturally noteworthy sites.

Site Density. The density patterns of historic sites make up a variable extremely important to planners. Three ranks were assigned: low for very few sites due either to normal site patterning or extensive land alteration, moderate for scattered clusters of sites, and high for continuous sites. Valleys with moderate or high density patterns are generally considered moderate or high sensitivity areas.

Site Specific Significance. The site specific significance variable was developed for valleys that had low densities of sites (very few sites) due either to normal site patterning or to extensive land alteration. An example of the first type might be a valley with housing sites on the side but too narrow for taro or housing sites on the valley floor. The second type might be a valley in which there had been sugar cane cultivation but a large heiau was left.

The site specific significance of these valleys was categorized as either 1) sites significant solely for information content which can undergo archaeological data recovery or 2) sites significant for multiple criteria and merit preservation consideration. Those categorized as meriting preservation consideration would likely include large heiaus, burial sites, and excellent examples of site types.

Overall Sensitivity. The overall sensitivity of a valley was ranked very high, high, moderate, low or unknown. Very high sensitivity areas have moderate or high densities of sites with little or no land alteration. They are extremely important archaeological and/or cultural areas. High sensitivity areas have moderate or high densities of sites with little or no land alteration. Moderate sensitivity areas have very few sites with the sites meriting preservation consideration due to multiple criteria *or* moderate densities of sites with moderate land alteration. Low sensitivity areas have very few sites due to normal site patterning or due to extensive land alteration. The sites present are significant solely for their informational content, which enables mitigation through data recovery. Those valleys where no surveying had been undertaken and the ability to predict what might be found was low were ranked unknown.

Historic Resources

Several types of sites were considered for inclusion in this section, particularly bridges, sugar mills and irrigation systems. Those that are listed on the State or National register were inventoried but none of them assessed.

Bridges. State bridge inventories have been compiled for the islands of Kauai, Oahu, Maui and Hawaii. Each of these inventories addressed evaluation in a different way. The Kauai and Hawaii inventories used a similar system: Category 1: Preserve; and, Category 2: Photograph before destruction. Only Category 1 bridges were listed on Oahu. The Maui inventory used a scoring system. HSA included all Category 1 or 2 bridges on Kauai and Hawaii, Category 1 on Oahu, and all bridges that received a score greater than 0 on Maui. The categories and scores are noted in the database.

Historic Register Sites. All properties listed on the State and National Registers and determined to be stream-related were included in the inventory. These include selected bridges, buildings, mills and irrigation systems.

Modern Resources

Streams and stream water have been and continue to be an integral part of the Hawaiian lifestyle. The committee identified a number of factors important to current Hawaiian practices. These include current taro cultivation, the potential for taro cultivation, appurtenant rights, subsistence gathering areas and stream-related mythology. The committee felt that a complete assessment of the cultural resources of Hawaii's streams should include these items but, due to limits of information, only the current cultivation of taro was included.

Taro Cultivation. Streams that currently supply irrigation water for taro cultivation were included. Contemporary taro raising falls into two basic categories: The large farm producing taro for commercial purposes, and the small diversified farm growing taro as one of several crops, usually part of a subsistence life style.

Information about streams that supply water for taro, along with approximate acreage, was taken from the Declaration of Water Use certification list (November 1989). This was augmented and adjusted by the Cultural Resources Committee. (The information is not verified so it is impossible to make any more than general estimates of actual acreage of taro cultivation.) Acreage was estimated by the HSA only to determine those valleys where taro was truly a part of the large landscape.

Assessment

The committee determined that the data for historic and modern resources were inadequate and should not be made a part of the cultural assessment. Therefore, the ranks are based solely on archaeological data.

Cultural Resources Ranking Criteria	
Outstanding:	High or very high archaeological sensitivity
Substantial:	Moderate archaeological sensitivity
Moderate:	Rank not used
Limited:	Low archaeological sensitivity
Unknown/ Unclassified:	Archaeological sensitivity unknown

Results

Inventory

Archaeological Resources

Archaeological data of some sort were available for about 250 streams. Of these, 180 had at least one site, 44 had 10 or more sites, 24 had 20 or more and three had 100 or more. These three are Kahana Stream on Oahu, Waihanau Stream on Molokai, and Waikaloa on Hawaii. However, these numbers reflect the findings of archaeological surveys conducted thus far; future surveys will find many more sites in other stream valleys. Ninety-six streams meet the National Register criterion C, having excellent examples of a type of site (Table 33).

Only 11 streams were determined to have complete survey coverage, yet the archaeologists had "high" confidence in their ability to predict what sites might be found on 55 streams.

Fifty streams have archaeological site densities considered high by the experts. Of the streams with low densities due either to normal site patterning or extensive land alteration, archaeologists believe that 32 have sites which merit preservation considerations, while 13 have sites important only for their information.

Historic Resources

Inventories were compiled for the islands of Kauai, Oahu, Maui and Hawaii. Out of the 85 bridges selected for inclusion in the HSA inventory, 23 are Category 1 bridges (recommended for preservation)(Table 31).

Modern Resources

Fifty streams were identified as providing water for taro irrigation. Six stream-related research and educational facilities are associated with taro. On Kauai, the USFWS Wildlife Refuge on the Hanalei (2-1-19), the Department of Agricultural Experimental Station on the Wailua (2-2-8s), and the National Tropical Botanical Gardens on the Limahuli (2-1-12); on Oahu, the UH Research and Experimental Station Ka Papa Lo'i O Kanewai and the Lyon Arboretum, both on the Manoa Stream (3-1-07.01), the Hawaii Nature Center on the Moleka tributary of the Ala Wai Canal System (3-3-07s), and Kaala Farms at Waianae on the Kaupuni (3-3-05).

There are eight poi mills: On Kauai, Waimea Poi and Kapaa Poi; on Oahu, Haleiwa Poi, Kalihi Poi and Honolulu Poi; on Maui, Aloha Poi; and on Hawaii, Pueo Poi. The Taro Farmers Co-op plans a mill on Molokai. None of these mills appears to use stream water.

Assessment

Ninety-five streams were identified as Outstanding by the Cultural Resources Committee. These were all of the streams identified as having high or very high sensitivity for archaeological reasons. Historic and modern cultural resources were not included in the assessment process due to the limited amount of information available (Table 33).

Vignettes

The State Historic Preservation Division's Ross Cordy prepared thumbnail sketches, or vignettes, of five valleys that have significant archaeological evidence indicating prehistoric settlements of some magnitude or importance.

Hanalei Valley, Kauai

Hanalei Valley lies within the traditional ahupua'a of Hanalei, the largest ahupua'a in the Halalea district. It is a windward valley characterized by broad alluvial flats that flank the Hanalei River narrowing as one proceeds up the long upper valley. Prehistoric archaeological sites are still present in the valley today. Remnents of taro fields and canals are in the lower valley and on the flats in the upper valley. House sites are present in the upper valley and along the lower valley's dry slopes in scattered clusters, and were once present along the shore. Other sites include religious structures like Po'oku heiau found on the eastern bluff.

Interestingly, for a valley of considerable importance within its district and on the island, archaeological survey in Hanalei is still quite limited. The best coverage is in the Hanalei National Wildlife Refuge in the lower valley, where a number of house sites and buried taro fields have been found. Excavation in cultural deposits that may pre-date the irrigated taro fields have yielded dates from ca. the A.D. 600s, which are quite early dates for Kauai.

Wailua Valley, Kauai

The Wailua River is on the eastern, windward side of Kauai in the ancient district of Puna. This river has a long drainage with two major forks, north and south. Wailua's renown is as the major royal center of Kauai in late prehistory. The royal and high ranking residential areas with their associated major heiau and a pu'uhonua were focused at the mouth of the river in the lower valley. A number of ruins of this royal center remain today: the pu'uhonua area, four heiau, royal birthstones, petroglyphs and a sacrificial rock. Many of these sites are protected within a state park.

Other historic sites do exist in the Wailua drainage, however. The agricultural fields which supported the elite and the commoners were scattered along the valley floor, and remnants of the irrigated taro fields and canals are present here and there as well as stone field terraces along the slopes of the valley. Historical places associated with oral histories of people and underwater caves exist above Wailua Falls.

Waihe'e Valley, Maui

Oral and written historical accounts indicate that the four large valleys of Maui – Waikapu, Wailuku, Waiehu, and Waihe'e – known as Na Wai Eha or Na Wai Kaulana, contained some of the largest continuous areas of wet taro cultivation in the islands and one of the densest populations. Agricultural terraces and irrigation systems still exist today in these valleys.

Wailuku was one of the most important royal centers on Maui. Unfortunately, much of the lower valley has long been altered, although the Halekii-Pihana heiau are still present. The lands at Waihe'e are closely associated with major figures of later prehistoric times and Kamehameha's time. These lands were held around 1765 by Namahana, a daughter of a ruler of Maui (Kekaulike) and wife to her half-brother and ruler (Kamehamehanui). With Kamehamehanui's death and the start of Kahekili's reign, she married Ke'eaumoku – a Hawai'i Island high chief who had fled Hawai'i after a failed revolt – and they resided in Waihe'e. Kahekili and the Ke'eaumoku-Namahana faction clashed in a battle known as Kalae'ili'ili. In this battle, Kahekili prevailed, and Ke'eaumoku and Namahana fled, eventually returning to Hawai'i Island, where Ke'eaumoku became one of the four major advisers to Kamehameha.

Waihe'e contains important archaeological remains. These include one of the earliest occupations for Maui identified so far – subsurface deposits along the coast dating back to A.D. 900-1200. Two heiau and surface remains of some coastal village settlements are also found in this shore area. In the upper reaches of the valley, numerous intact taro terraces are still present.

Halawa Valley, Molokai

From an archaeological viewpoint, Halawa Valley is one of the best studied valleys in Hawaii – with results providing an understanding of continuous windward settlement spanning nearly 1,200 years, from prehistoric through historic times. Evidence of very early occupation of the valley was identified in a subsurface coastal site in the sand areas adjacent to the mouth of Halawa Stream. Postmolds, hearths, and stone-lined and paved structural foundations were uncovered, along with artifacts and food remains. These remains date back to A.D. 600-1200. The inland portion of the valley was evidently permanently occupied in the period from A.D. 1200-1400. Residential sites and wet and dry agricultural complexes are found on both sides of the valley floor.

Waipi'o Valley, Hawai'i

Waipi'o Valley is renowned on Hawai'i Island as a place with many significant historic sites, with rich oral historical records, and as a place where cultural lifeways of an older Hawai'i still can be seen and felt. Waipi'o appears to have been the ruling center that first unified the Island of Hawai'i, perhaps in the A.D. 1400s. Here, the Pili line developed their power, with Liloa and his son Umi two of the most famous earlier rulers of the Pili line.

Kamehameha was also a ruler in this line. The royal residence was just behind the sand dune at the mouth of the valley, with a pu'uhonua and luakini heiau. Paka'alana, and a royal mausoleum, Hale o Lono, adjacent. The large heiau of Honua'ula was also in the dune area, as was an arena for boxing and other sports. Other heiau were scattered about in the lower valley. Deposits – probably associated with these royal features – are still present in the dune with stone pavings and walls visible. Other heiau are visible as large platforms.

Waipi'o was also a population center on Hawai'i, with about 2,500 people probably in residence when Captain Cook arrived, making Waipi'o one of the densest population centers in the islands. Houses were located on the dunes and along the valley sides at the base of the cliffs and across the mouth of the side valley of Hi'ilawe. Today, many of these areas contain archaeological remains of house sites – stone pavings, platforms and enclosures.

Waipi'o was also an economic center, a massive supplier of taro. The entire valley floor was a maze of taro lo'i fed by numerous canals ('auwai) leading from the main stream, from side streams such as Hi'ilawe, and from the base of waterfalls along the valley sides. Many of these taro lo'i and canals are present today. Some are buried under more modern taro, rice and other fields. Fishponds were also present in the valley, with two huge fishponds at the front of the valley behind the dune – Lalakea and Muliwai. The ruins of both are present today, walls and internal silt deposits. Sweet potatoes and other crops were planted in dry areas along the slopes at thebase of the valley walls, and archaeological remains of these fields also remain as stone terraces and mounds.

Table 31 Category 1 Bridges

	Bridge Name	Stream Name
Kauai		
	Waipa	Waipa
	Waioli	Waioli
	Hanalei	Hanalei
	Moloaa	Moloaa
	Wailua	Wailua
	Waikomo	Waikomo
	Wahiawa	Wahiawa
	Hanapepe	Hanapepe
	Waimea	Waimea
Oahu		
	Wailele Gulch	Wailele
	Kaneohe	Kaneohe
	Ala Wai Canal	Ala Wai System
	Manoa	Ala Wai System
	Palolo	Ala Wai System
	Nuuanu	Nuuanu

Kipapa	Kipapa
Honouliuli	Honouliuli
Makaha	Makaha

Hawaii

Kealakaha	Kealakaha
Mamalahoa/Hakalau	Hakalau
Mamalahoa/Honolii	Honolii
Mamalahoa/Pukihae	Pukihae
Keawe Street/Wailuku	Wailuku

Table 32 Streams used for Taro Cultivation

Greater than 50 acres

Waioli (2-1-18)
Hanalei (2-1-19)
Waihee (6-2-07)
Waiehu (6-2-08)
Piinaau (6-4-11)
Wailoa/Waipio (8-1-44)

10 to 50 acres of taro

Hanapepe, (2-3-07)
Waimea (2-4-04)
Punaluu (3-1-16)
Waiahole (3-2-04)
Kaalaea (3-2-05)
Kahuluu System (3-2-07s)
Honokohau (6-1-11)
Iao (6-2-09)
Honopou (6-3-08)
Hoolawa (6-3-09)
Hanehoi (6-3-11)
Waiokamilo (6-4-13)
Opelu (6-5-15)
Niulii (8-1-13)
Ninole (8-2-21).
Kahakuloa (6-2-03)

Up to 10 acres of taro

Limahuli (2-1-12)
Wainiha (2-1-14)
Waipa (2-1-17)
Anini (2-1-21)
Kilauea (2-1-28)
Anahola (2-2-01)
Wailua S. (2-2-08s)

Nawiliwili (2-2-13)
Puali (2-2-14)
Huleia (2-2-15)
Punaluu (3-1-16)
Waianu (3-2-03)
Kahaluu S. (3-2-07s)
Ala Wai S. (3-3-07s)
Nuuanu (3-3-09)
Paukauila S. (3-6-07s)
Anahulu S. (3-6-08s)
Honouliwai (4-2-03)
Waialua (4-2-04)
Mapulehu (4-2-08)
Kauaula (6-1-04)
Waikapu (6-2-10)
Nuaailua (6-4-10)
Ohia (6-4-12)
Wailuanui (6-4-14)
Kawaipapa (6-4-34)
Opelu (6-5-16)
Aamakao (8-1-12)
Kilau (8-2-05)

Discussion

Much of Hawaiian settlement was concentrated around streams, and to that degree the archeological record can be considered stream-related. However, subsequent settlement has obliterated most of this record. The ancient relationship between the stream and the land can best be seen in those valleys which have gone through least change, such as those described in the vignettes. Protection of this relationship is most appropriate in stream planning in these and similar valleys. In most other places, the archeological resource is no longer dependent on water being in the stream.

Limitations

The inventory and assessment of cultural resources is incomplete. While the inventory of archaeological resources is well addressed, the historic resource data has not been collected in a consistent enough manner to be useful for assessment purposes. Modern cultural elements are sorely lacking. As a result, the criteria for assessment does not include historic or modern cultural elements, nor are they particularly selective among the archaeological resources.

The listing of archaeological information should be used only as a general guide for planners, drawing attention to stream valleys with outstanding or substantial rankings. The details of historic site information are available at the state's Historic Preservation Division.

Taro information is incomplete because it was taken from the DLNR Declaration of Water Use, which was not designed to identify taro cultivation. It is anticipated that the completed declaration process will provide more definitive answers to this cultural resource.

Future Research

Archaeological survey coverage will gradually increase over time which will improve information and predictions for many of Hawaii's streams. Periodic updating of this assessment could occur in coordination with the state Historic Preservation Division, as this office maintains the state Inventory of Historic Places and archaeological information. Also, archaeological surveys could be funded for some valley types and areas for which information is completely lacking and where predictions cannot yet be made.

Expansion of the inventory of historic and modern cultural resources is needed, especially historic districts. Districts are widely recognized as major historic assets and can range from urban districts, such as Chinatown, to communities, such as Hanapepe or Lahaina, to rural landscapes, such as Hanalei or Keanae. Because of man's historic tendency to settle near water, many districts are stream related.

Among modern cultural resources, there is a need for an inventory of appurtenant rights, established at the time of the mahele. Other inventories needed include streams with riparian lands considered prime for taro cultivation and the streams associated with Hawaiian gathering practices. The subjective and intangible resources of history and lore as told through songs, chants, legends, while extremely important culturally, do not lend themselves to assessment.

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Table 33 Cultural Resources

CODE HSA code; island-hydrographic unit-stream

STREAM Stream name at mouth

ARCHAEOLOGICAL

SURV COVR Extent of survey coverage

- C Complete
- P Partial
- L Very limited
- N None

PRE-DICT Abilities to predict what historic sites might be in unsurveyed areas.

- H Substantial information exist to assist prediction
- L Little or no information exists to assist prediction
- M All others

\# SITES Rough estimates of total number of archaeological sites

DENSITY

- H Continuous sites
- M Scattered clusters of sites
- L Very few sites

VALLEY Significance of valley as district using National Register of Historic Places Criteria

- A Pre-contact or early contact
- B Associated with important people or dieties
- C Excellent examples of site type
- D Contains important information
- E Contains culturally noteworthy sites

SENSI-TIVE Overall sensitivity of a valley based on density of archaeological sites and land disturbance.

- V Very high
- H High
- M Moderate
- L Low

OTHER

HIST SITE A historic or potentially historic resource has been associated with this stream (usually a bridge).

TARO Taro cultivation has been associated with this stream.

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
Kauai									
2-1-01	Awaawapuhi	P	M	9	H	ACDE	H		
2-1-02	Honopu	C	M	8	H	ACDE	H		
2-1-03	Nakeikionaiwi	N	M		H	ACDE	H		
2-1-04	Kalalau	P	H	26	H	ACDE	H		
2-1-05	Pohakuao	P	M	6	M	CD	H		
2-1-06	Waiolaa	P	M	6	H	CD	H		
2-1-07	Hanakoa	C	H	9	H	ACDE	H		
2-1-08	Waiahuakua	P	L	2	M	CD	H		
2-1-09	Hoolulu	N	L				H		
2-1-10	Hanakapiai	P	H	21	H	ACDE	H		
2-1-11	Maunapuluo	P	H	17	H	ACDE	H		
2-1-12	Limahuli	P	L	4	M	CDE	H		Y
2-1-13	Manoa	L	L	1	M	CD	H		
2-1-14	Wainiha R.	L	L	4	M	CD	H		Y
2-1-15	Lumahai R.	L	L	10	M	CD	H		
2-1-16	Waikoko	N	L						Y
2-1-17	Waipa	L	L	6	H	ACDE	H	Y	Y
2-1-18	Waioli	L	L	3	M	ACDE		Y	Y

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
2-1-19	Hanalei R.	P	M	15	H	ACDE	H	Y	Y
2-1-20	Waileia	P	M	2	L	AD	M		
2-1-21	Anini	L	L	2	M	D			Y
2-1-25	Kalihiwai R.	L	L	2	L	ACDE	M		
2-1-26	Puukumu							Y	
2-1-27	Unnamed	N	L		L				
2-1-28	Kilauea	L	L	1	L	ACDE			Y
2-1-29	Kulihaili	N	L		L		L		
2-1-30	E. Waiakalua	L	L	3	H	ACDE	H		
2-1-31	Pilaa	L	L	2	L	ACD	M		
2-1-32	W. Waipake	L	L	5	L	ACD	M		
2-1-33	E. Waipake	N	L		M				
2-1-34	Moloaa	N	L		L			Y	
2-1-35	Papaa	L	L	3	M	ACD	H		
2-1-36	Aliomanu	N	L		L				
2-2-01	Anahola	L	L	5	M	ACD	M		Y
2-2-02	Kumukumu	N	L		L				
2-2-04	Kapaa	L	L	2	L	CDE	M		
2-2-05	Moikeha Canal	N	L		L				
2-2-06	Waikaea Canal	L	L	2	M	CDE	M		
2-2-08s	Wailua S.	C	H	6	H	ABCDE	H		Y
2-2-10	Kawailoa	N	L		L				
2-2-12	Hanamaulu	L	L	1	L	D	L	Y	
2-2-13	Nawiliwili	N	L		L		L	Y	Y
2-2-14	Puali	L	L	1	L	BCDE	L		Y
2-2-15	Huleia	L	L	1	L	AD	L	Y	Y
2-3-01	Kipu Kai	N	L		L		L		
2-3-02	Waikomo	P	M	16	H	CDE	H	Y	
2-3-04	Lawai	L	L	6	H	CDE	H	Y	
2-3-06	Wahiawa	P	M	6	M	CDE	H	Y	
2-3-07	Hanapepe	P	M	8	M	CDE	H	Y	Y
2-4-01	Mahinauli	N	L						
2-4-02	Aakukui	N	L						
2-4-03	Waipao	N	L						
2-4-04s	Waimea S.	P	M	8	M	ACDE	H	Y	Y
2-5-06	Kinekine Ditch	N	L						
2-5-07	Kaawaloa	N	L						
2-5-08	Nahomalu	L	L	1	M	CDE	H		
2-5-09	Kaulaula	L	L	1	M	AD	H		
2-5-10	Haeleele	L	L	4	M	AD	H		
2-5-13	Kauhao	L	L	1	M	AD	H		
2-5-15	Milolii	C	H	24	H	ACDE	H		
2-5-16	Nualolo	C	H	25	H		H		

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
Oahu									
3-1-03	Paumalu	P	H	10	M	CD	M		
3-1-04	Kawela	N	L						
3-1-05	Oio	L	L	3	L	D	M		
3-1-06	Malaekahana	N	L	1					
3-1-07	Kahawainui	P	M	4	L	CD	M	Y	
3-1-08	Wailele Gl.	N	L					Y	
3-1-09	Koloa Gl.	N	L					Y	
3-1-10	Kaipapau	L	M	1	L	CDE	M		
3-1-11	Maakua	L	M	2	M	CD	M		
3-1-13	Kaluanui	P	M	20	M	CDE	M		
3-1-16	Punaluu	P	M	29	H	CDE	M		Y
3-1-18	Kahana	C	H	125	H	DE	H		
3-1-19	Kaaawa	N	L	2					
3-1-20	Makaua								
3-1-21	Unnamed								
3-2-01	Hakipuu	P	H	1	H	CDE	M		
3-2-02	Waikane	P	M	10	M	CDE	M		
3-2-03	Unnamed	P	M	7	M	CDE	M		Y
3-2-04	Waiahole	P	M	26	M	CDE	M		Y
3-2-05	Kaalaea	N	L						Y
3-2-07s	Kahaluu S.	L	M	1	L	CDE	M		Y
3-2-08	Heeia	L	L	1					
3-2-09	Keaahala	N	L						
3-2-10	Kaneohe	N	L					Y	
3-2-11	Kawa	N	L					Y	
3-2-13	Kawainui/ Maunawili	P	H	10	M	CDE	H	Y	
3-2-14	Kaelepulu Canal								Y
3-2-15	Waimanalo	P	H	4	L	D	H		
3-3-03	Kuliouou	L	L	17		D			
3-3-04	Niu	N							
3-3-05	Wailupe	N						Y	
3-3-06	Waialaenui	N							
3-3-07s	Ala Wai S.	N	L	1				Y	Y
3-3-09	Nuuanu	P	L	8				Y	Y
3-3-10	Kapalama	P	L	6				Y	
3-3-11	Kalihi	P	L	6				Y	
3-3-12	Moanalua	C	H	53	H	H?	H		
3-4-02	Halawa	P	H	75	H	D	H		
3-4-03	Aiea	N	L	1		DE			
3-4-04	Kalauao	N	L	1					
3-4-05	Waimalu	N						Y	
3-4-06	Waiawa	N							

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
3-4-10	Waikele	L	M	10	L	D	L		
3-4-11	Honouliuli	L	H	10	M	D	L	Y	
3-5-01	Nanakuli	P	H	35	H	CDE	M		
3-5-02	Ulehawa	N	L						
3-5-04	Mailiili	N	L						
3-5-05	Kaupuni	L	H	25	M	CDE	H		Y
3-5-07	Makaha	C	H	75	H	CDE	M	Y	
3-5-08	Makua	N	L						
3-6-03	Unnamed	N	L						
3-6-04	Makaleha	N	L						
3-6-06s	Kiikii S.	N	L						
3-6-07s	Paukauila S.	L	L						Y
3-6-08s	Anahulu S.	P	H						Y
3-6-09	Loko Ea	L	L	2				Y	
3-6-10	Waimea R.	P	H	10	M	DE	M	Y	
				Molokai					
4-1-01	Waihanau	P	H	307	H	ACDE	H		
4-1-02	Waialeia	L	M	1	M	ADE	M		
4-1-03	Waikolu	L	M	1	M	ADE	M		
4-1-04	Wainene	N							
4-1-05	Anapuhi	L	L	1	L	AD	M		
4-1-06	Waiohookalo	N							Y
4-1-07	Keawanui	N							
4-1-08	Kailiili	L	H	1	H	ACD	H		
4-1-09	Pelekunu	L	H	3	H	ACDE	V		
4-1-10	Waipu	N							
4-1-11	Haloku	N							
4-1-12	Oloupena	N							
4-1-13	Puukaoku	N							
4-1-14	Wailele	N							
4-1-15	Wailau	L	H	6	H	ACDE	V		
4-1-17	Waiahookalo	N							
4-1-18	Kahiwa	N							
4-1-19	Kawainui	N							
4-1-20	Pipiwai	N							
4-1-21	Halawa	C	H	20	H	ACDE	V		
4-1-22	Hakaaano	N	L						
4-2-01	Pohakupili	L	M	3	M	ADE	M		
4-2-02	Honoulimaloo	L	M	1	H	ADE	H		
4-2-03	Honouliwai	L	M	2	H	ADE	H		Y
4-2-04	Waialua	L	H	4	H	ACDE	H		Y
4-2-05	Kainalu	L	H	10	H	ACDE	H		

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
4-2-06	Honomuni	L	H	3	M	ADE	M		
4-2-08	Mapulehu	L	H	2	M	ACDE	H		Y
4-2-09	Kaluaaha	L	H	4	H	ACDE	H		
4-2-10	Kahananui	L	M	1	M	ADE	M		
4-2-11	Manawai	L	H	6	M	ACDE	H		
4-2-12	Ohia	L	M	5	M	ACDE	M		
4-2-13	Wawaia	L	M	2	M	ADE	M		
4-2-14	Kamalo	P	H	10	H	ACDE	H		
4-2-15	Kawela	P	H	15	H	ACDE	V		
Maui									
6-1-01	Ukumehame	L	M	2	L	ADE	M		
6-1-02	Olowalu	L	M	3	L	ADE	M		
6-1-03	Launiupoku	N							
6-1-04	Kauaula	N							
6-1-05	Kahoma	P	M	3	M	ADE	M		
6-1-06	Wahikuli	N							
6-1-07	Honokowai	L	M	5	M	AD	M		
6-1-08	Kahana	N							
6-1-09	Honokahua	L	M	3	M	ADE	M		
6-1-10	Honolua	P	H	10	M	ADE	H	Y	
6-1-11	Honokohau	L	H	1	M	ACDE	H		Y
6-2-01	Poelua	N							
6-2-02	Honanana	L	L	1	L	ADE	L		
6-2-03	Kahakuloa	L	H	1	H	ADE	H		Y
6-2-05	Waiolai	L	L	1	L	ADE	M		
6-2-06	Makamakaole	L	M	1	L	ADE	M		
6-2-07	Waihee R.	P	H	14	M	ADE	H		Y
6-2-08	Waiehu	L	M	2	L	ADE	M		Y
6-2-09	Iao	N							Y
6-2-10	Waikapu	L	M	10	M	ADE	M	Y	Y
6-3-01	Maliko	L	M	1	M	ADE	M		
6-3-02	Kuiaha	N							
6-3-03	Kaupakulua	L	L	1	L	AD	M		
6-3-04	Manawaiiao	N							
6-3-05	Uaoa	N							
6-3-07	Kakipi	L	L	1	L	ADE	M		
6-3-08	Honopou	L	L	1	L	ADE	M		Y
6-3-09	Hoolawa	L	M	1	M	ADE	M		Y
6-3-10	Waipio	N							
6-3-11	Hanehoi	N							Y
6-3-12	Hoalua	L	M	2	L	ADE	M	Y	
6-3-13	Hanawana	L	M	1	L	ADE	M		

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
6-3-14	Kailua	L	M	2	L	AD	M	Y	
6-3-15	Nailiilihaele	N						Y	
6-4-01	Oopuola	N						Y	
6-4-02	Kaaiea	N						Y	
6-4-03	Kolea	N							
6-4-04	Waikamoi	N						Y	
6-4-06	Puohokamoa	N						Y	
6-4-07	Haipuaena	N						Y	
6-4-08	Punalau	N						Y	
6-4-09	Honomanu	N						Y	
6-4-10	Nuaailua	N						Y	Y
6-4-11	Piinaau	N						Y	Y
6-4-12	Ohia	L	L	1	L	ADE	M		Y
6-4-13	Waiokamilo	N						Y	Y
6-4-14	Wailuanui	L	M	1	M	ADE	M		Y
6-4-15	W. Wailuaiki	N						Y	
6-4-16	E. Wailuaiki	N						Y	
6-4-17	Kopiliula	N						Y	
6-4-18	Waiohue Gl.	N						Y	
6-4-19	Paakea	N							
6-4-20	Waiaaka	N							
6-4-21	Kapaula	N						Y	
6-4-22	Hanawi	N						Y	
6-4-23	Makapipi	L	M	3	M	ADE	H	Y	
6-4-24	Kuhiwa	N						Y	
6-4-25	Waihole	N							
6-4-26	Manawaikeae	N						Y	
6-4-27	Kahawaihapapa	N						Y	
6-4-28	Keaaiki	N						Y	
6-4-29	Waioni	N						Y	
6-4-30	Lanikele	N						Y	
6-4-31	Heleleikeoha	N						Y	
6-4-32	Kawakoe	N							
6-4-33	Ulaino	L	M	1	M	ACDE	M	Y	
6-4-34	Kawaipapa	L	M	6	M	ADE	M		Y
6-5-01	Moomoonui	L	L	1	L	ADE	M		
6-5-02	Haneoo	L	L	2	L	ADE	M		
6-5-03	Kapia	N						Y	
6-5-04	Waiohonu	L	M	1	L	AD	M	Y	
6-5-05	Papaahawahawa	L	M	1	M	ADE	M		
6-5-06	Alaalaula	L	H	1	M	ADE	M		
6-5-07	Wailua	N							
6-5-08	Honolewa	N							
6-5-09	Waieli	N							

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
6-5-10	Kakiweka	N							
6-5-11	Hahalawe	N							
6-5-12	Puaaluu	L	L	1	M	ADE	M		
6-5-13	Oheo Gl	L	M	1	M	ADE	M	Y	
6-5-15	Koukouai	L	H	6	H	ACDE	H		
6-5-16	Opelu	N							Y
6-5-17	Kukuiula	N							
6-5-18	Kaapahu	N							
6-5-19	Lelekea	P	H	1	H	ACDE	H		
6-5-20	Alelele	L	H	1	M	AD	M		
6-5-21	Kalepa	L	M	1	L	ADE	M		
6-5-22	Nuanuaaloa	N							
6-5-24	Manawainui	L	H	6	M	ACDE	H		
Hawaii									
8-1-03	Kumakua	N	L						
8-1-06	Hanaula	N	L						
8-1-07	Hapahapai	N	L						
8-1-08	Pali Akamoa	N	L						
8-1-09	Wainaia	N	L						
8-1-10	Unnamed	N	L						
8-1-11	Halawa	L	H	5	M	ABCDE	H		
8-1-12	Aamakao	L	H	5	M	ACDE	H		Y
8-1-13	Niulii	L	M	10	M	ACDE	H		Y
8-1-14	Waikama	L	M	10	M	ABCDE	H		
8-1-15	Pololu	C	H	30	H	ACDE	H		
8-1-16	Honokane Nui	C	H	40	H	ACDE	H		
8-1-17	Honokane Iki	P	H	10	H	ACDE	H		
8-1-18	Kalele Gl.	N	L						
8-1-19	Waipahi	L	M	2	L	ACDE	H		
8-1-20	Honokea	N	L						
8-1-21	Kailikaula	N	L						
8-1-22	Honopue	L	H	4	M	ACDE	H		
8-1-23	Kolealiilii	N	L						
8-1-24	Ohiahuea	N	L						
8-1-25	Nakooko	L	M	1	H	ACDE	H		
8-1-26	Waiapuka	N	L						
8-1-27	Waikaloa	N	L						
8-1-28	Waimaile	N	L						
8-1-29	Kukui	N	L						
8-1-30	Paopao	N	L						
8-1-31	Waiaalala	L	M	1	H	ACDE	H		
8-1-32	Punalulu	L	M	1	H	ACDE	H		

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
8-1-33	Kaimu	L	M	1	H	ACDE	H		
8-1-34	Pae	L	M	1	H	ACDE	H		
8-1-35	Waimanu	P	H	40	H	ACDE	H		
8-1-36	Pukoa	N	L						
8-1-37	Manuwaikaalio	N	L						
8-1-38	Naluea	N	L						
8-1-39	Kahoopuu	N	L						
8-1-42	Waipahoehoe	N	L						
8-1-44	Wailoa/Waipio	P	H	75	H	ABCDE	V		Y
8-1-45	Lalakea	N	L						
8-1-46	Kaluahine Falls	N	M		M	ACDE	H		
8-1-47	Waiulili	N	M		M	ACDE	H		
8-1-49	Waipunahoe	N	M		M	ACDE	H		
8-1-50	Waialeale	N	M		M	ACDE	H		
8-1-51	Waikoloa	N	M		M	ACDE	H		
8-1-52	Kapulena	N	M		M	ACDE	H		
8-1-53	Kawaikalia	N	M		M	ACDE	H		
8-1-54	Malanahae	N	M		M	ACDE	H		
8-1-61	Nienie	N	L						
8-1-62	Papuaa	N	L						
8-1-65	Kahaupu	N	L						
8-1-66	Kahawailiili	N	L						
8-1-67	Keahua	N	L						
8-1-68	Kalopa	N	L						
8-1-69	Waikaalulu	N	L						
8-1-70	Kukuilamalamahii	N	L						
8-1-71	Alilipali	N	L						
8-1-73	Kaumoali Gl	N	L						
8-1-76	Waipunahina	N	L					Y	
8-1-77	Waipunalau Gl	N	L						
8-1-78	Paauilo	N	L						
8-1-79	Aamanu	N	L						
8-1-80	Koholalele Gl	N	L						
8-1-81	Kalapahapu Gl	N	L						
8-1-82	Kukaiau	N	L						
8-1-85	Kaala	N	L						
8-1-86	Kealakaha	N	L					Y	
8-1-88	Kupapaulua	N	L					Y	
8-1-89	Kaiwiki	N	L						
8-1-90	Kaula	N	L						
8-2-01	Kaohaoha	N	L						
8-2-02	Kaawalii	N	L						
8-2-03	Waipunalei	N	L						
8-2-04	Laupahoehoe	L	M	5	M	ACDE	M	Y	

CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
8-2-05	Kilau	N	L						Y
8-2-06	Manowaiopae	N	L						
8-2-07	Kuwaikahi	N	L						
8-2-08	Kihalani	N	L						
8-2-09	Kaiwilahilahi	N	L					Y	
8-2-10	Haakoa	N	L						
8-2-11	Pahale	N	L						
8-2-12	Kapehu	N	L						
8-2-13	Paeohe	N	L						
8-2-14	Maulua	N	L						
8-2-16	Pohakupuka	N	L						
8-2-17	Kulanakii	N	L						
8-2-18	Ahole	N	L						
8-2-19	Poupou	N	L						
8-2-20	Manoloa	N	L						
8-2-21	Ninole	N	L						Y
8-2-22	Kaaheiki	N	L						
8-2-23	Waikolu	N	L						
8-2-24	Waikaumalo	N	L						
8-2-25	Kahuku	N	L						
8-2-26	Waiehu	N	L						
8-2-27	Nanue	N	L						
8-2-28	Opea	N	L						
8-2-29	Peleau	N	L						
8-2-30	Umauma	N	L					Y	
8-2-31	Kamaee	N	L						
8-2-32	Hakalau	N	L					Y	
8-2-33	Kolekole	N	L					Y	
8-2-34	Paheehee	N	L						
8-2-35	Honomu	N	L						
8-2-36	Laimi	N	L						
8-2-37	Kapehu	N	L						
8-2-38	Makea	N	L						
8-2-39	Alia	N	L						
8-2-40	Makahanaloa	N	L						
8-2-41	Waimaauou	N	L						
8-2-42	Waiaama	N	L					Y	
8-2-43	Kawainui	N	L						
8-2-44	Onomea	N	L						
8-2-45	Alakahi	N	L						
8-2-46	Hanawi	N	L						
8-2-47	Kalaoa	N	L						
8-2-48	Aleamai	N	L						
8-2-49	Kaieie	N	L						

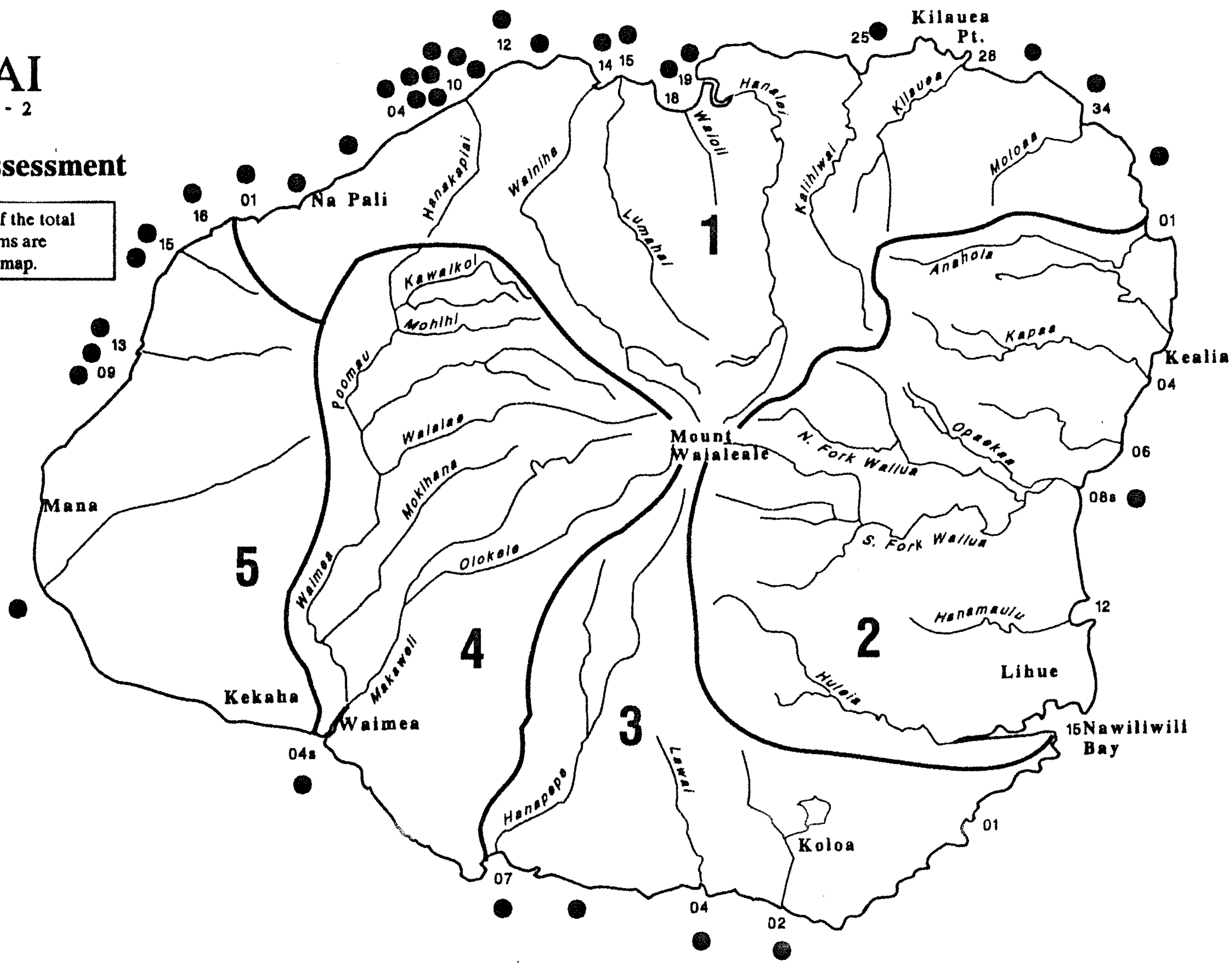
CODE	STREAM	ARCHAEOLOGICAL						OTHER	
		SURV COVR	PRE-DICT	# SITES	DEN-SITY	VALL-EY	SENSI-TIVE	HIST SITE	TARO
8-2-50	Puuokalepa	N	L					Y	
8-2-51	Kaapoko	N	L						
8-2-52	Papaikou	N	L						
8-2-53	Kapue	N	L						
8-2-54	Pahoehoe	N	L						
8-2-55	Paukaa	N	L						
8-2-56	Honolii	L	M	4	L	D	L	Y	
8-2-57	Maili	N	O						
8-2-59	Pukihae	N	L					Y	
8-2-60	Wailuku R.	L	L	5				Y	
8-2-61	Wailoa R.	L	M	5	M	ACDE	H		
8-2-62	Kaahakini		O						
8-4-02	Waiaha	N	L						
8-5-01	Haloa	N	L						
8-5-02	Lamimaumau	N	L						
8-5-03	Waikoloa	P	H	100	H	ABCDE	V		

Map 6
Outstanding Cultural Resources

KAUAI
Island Code - 2

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

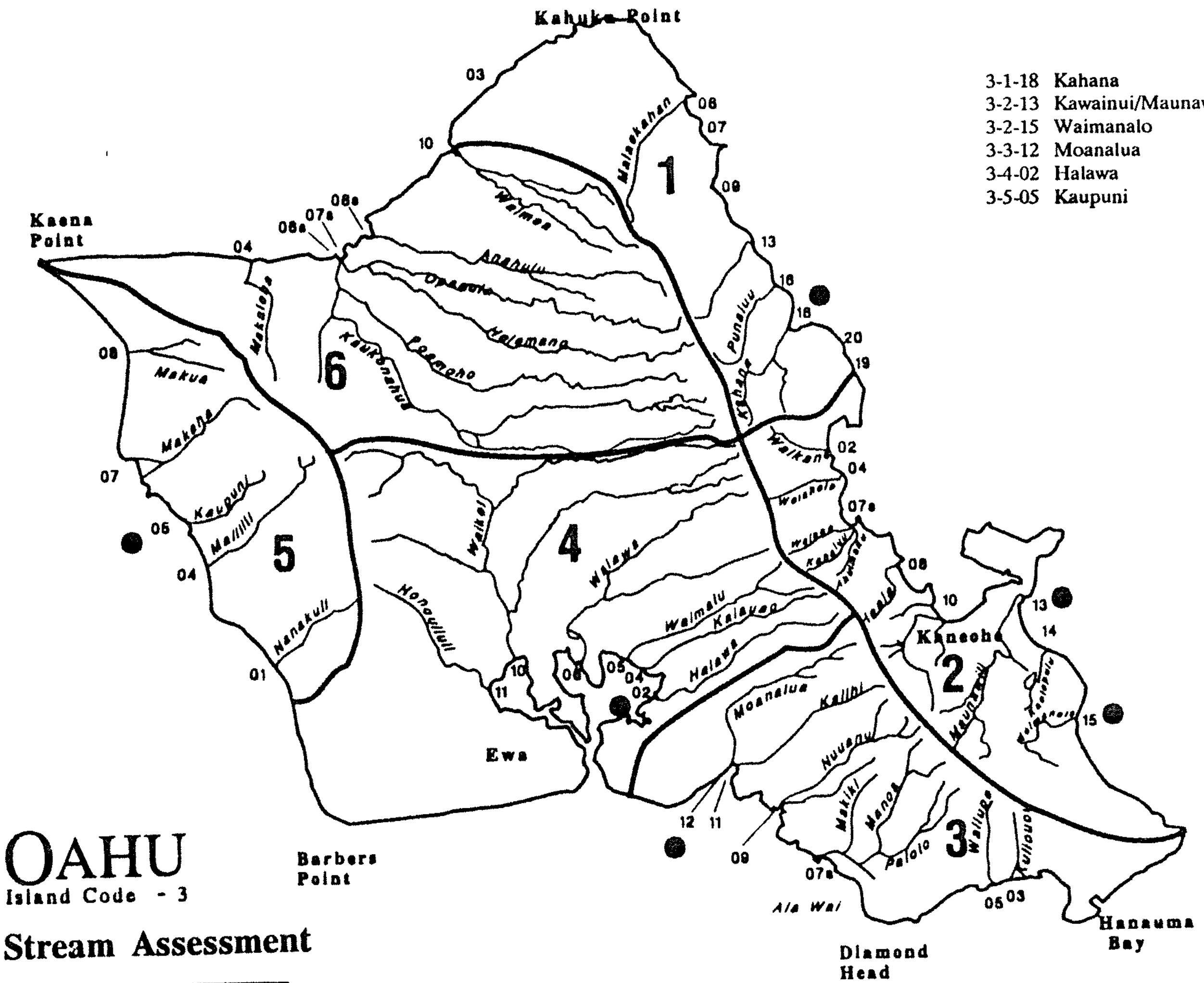


2-1-01 Awaawapuhi
2-1-02 Honopu
2-1-03 Nakeikionaiwi
2-1-04 Kalalau
2-1-05 Pohakuao
2-1-06 Waiolaa
2-1-07 Hanakoa
2-1-08 Waiahuakua
2-1-09 Hoolulu
2-1-10 Hanakapiai
2-1-11 Maunapuluo
2-1-12 Limahuli
2-1-13 Manoa
2-1-14 Wainiha R.
2-1-15 Lumahai R.
2-1-17 Waipa
2-1-19 Hanalei R.
2-1-26 Puukumu
2-1-30 E. Waiakalua
2-1-35 Papaa
2-2-08s Wailua S.
2-3-02 Waikomo
2-3-04 Lawai
2-3-06 Wahiawa
2-3-07 Hanapepe
2-4-04s Waimea S.
2-5-08 Nahomalu
2-5-09 Kaulaula
2-5-10 Haeleele
2-5-13 Kauhao
2-5-15 Milolii
2-5-16 Nualolo

Map 6

Outstanding Cultural Resources

3-1-18 Kahana
3-2-13 Kawainui/Maunawili
3-2-15 Waimanalo
3-3-12 Moanalua
3-4-02 Halawa
3-5-05 Kaupuni



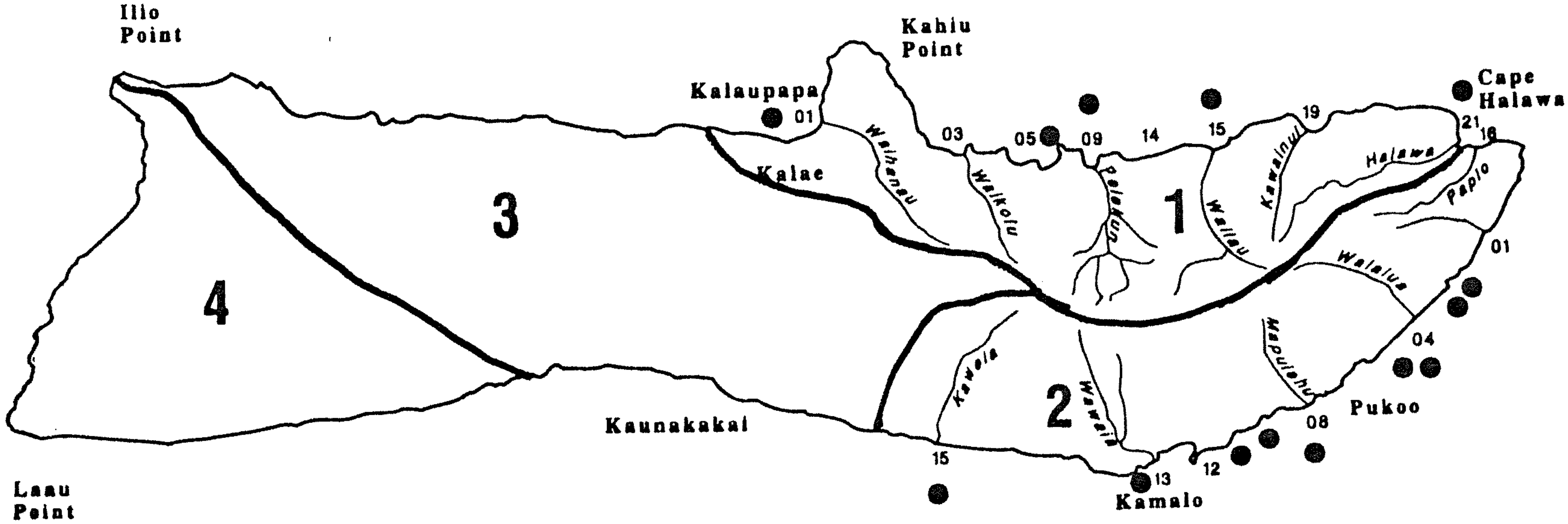
OAHU
Island Code - 3

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 6

Outstanding Cultural Resources



4-1-01 Waihanau
4-1-08 Kailiili
4-1-09 Pelekunu
4-1-15 Wailau
4-1-21 Halawa
4-2-02 Honoulimaloo
4-2-03 Honouliwai
4-2-04 Waialua
4-2-05 Kainalu
4-2-08 Mapulehu
4-2-09 Kaluaaha
4-2-11 Manawai
4-2-14 Kamalo
4-2-15 Kawela

MOLOKAI

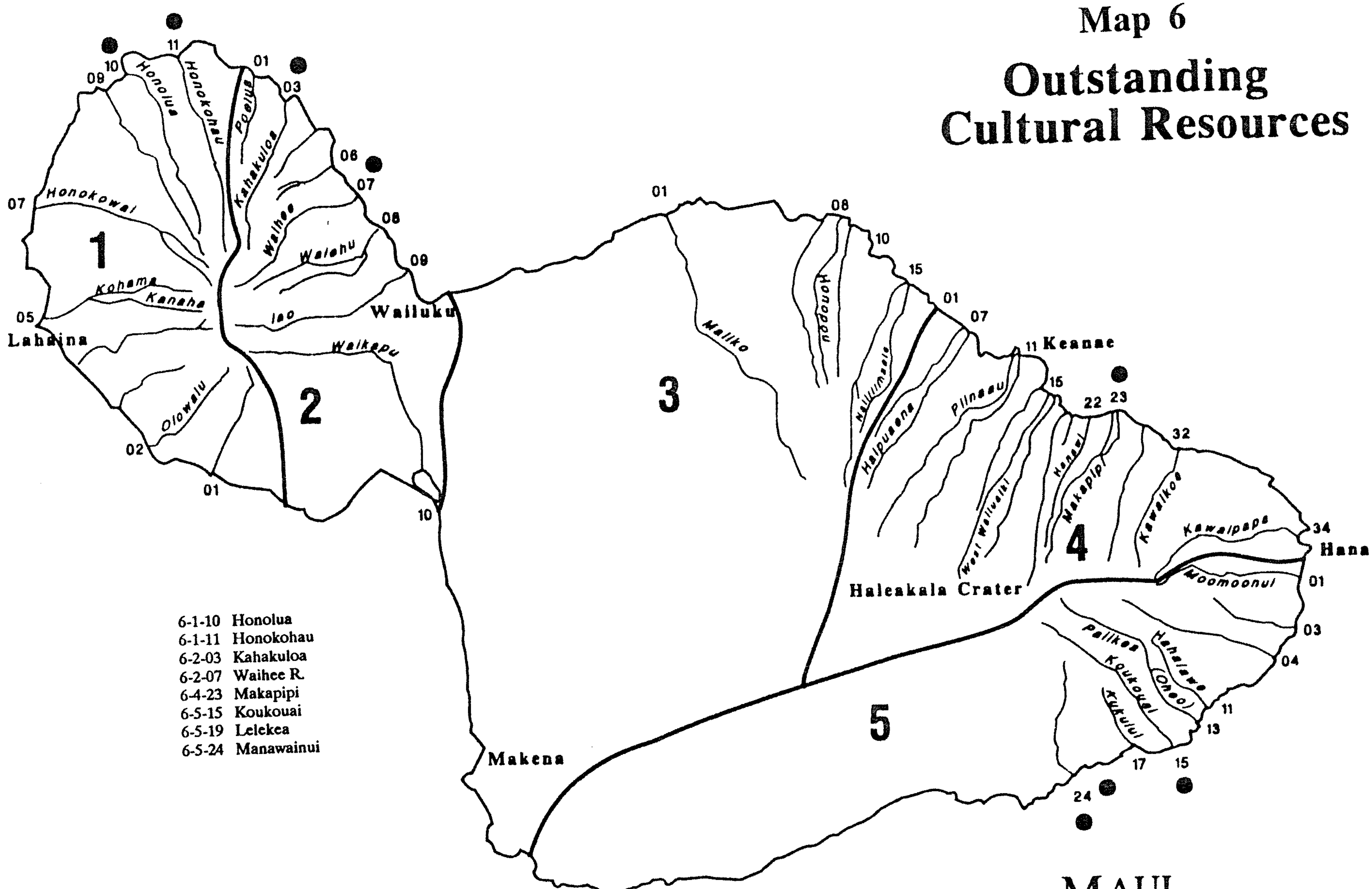
Island Code - 4

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 6

Outstanding Cultural Resources



6-1-10 Honolua
6-1-11 Honokohau
6-2-03 Kahakuloa
6-2-07 Waihee R.
6-4-23 Makapipi
6-5-15 Koukouai
6-5-19 Lelekea
6-5-24 Manawainui

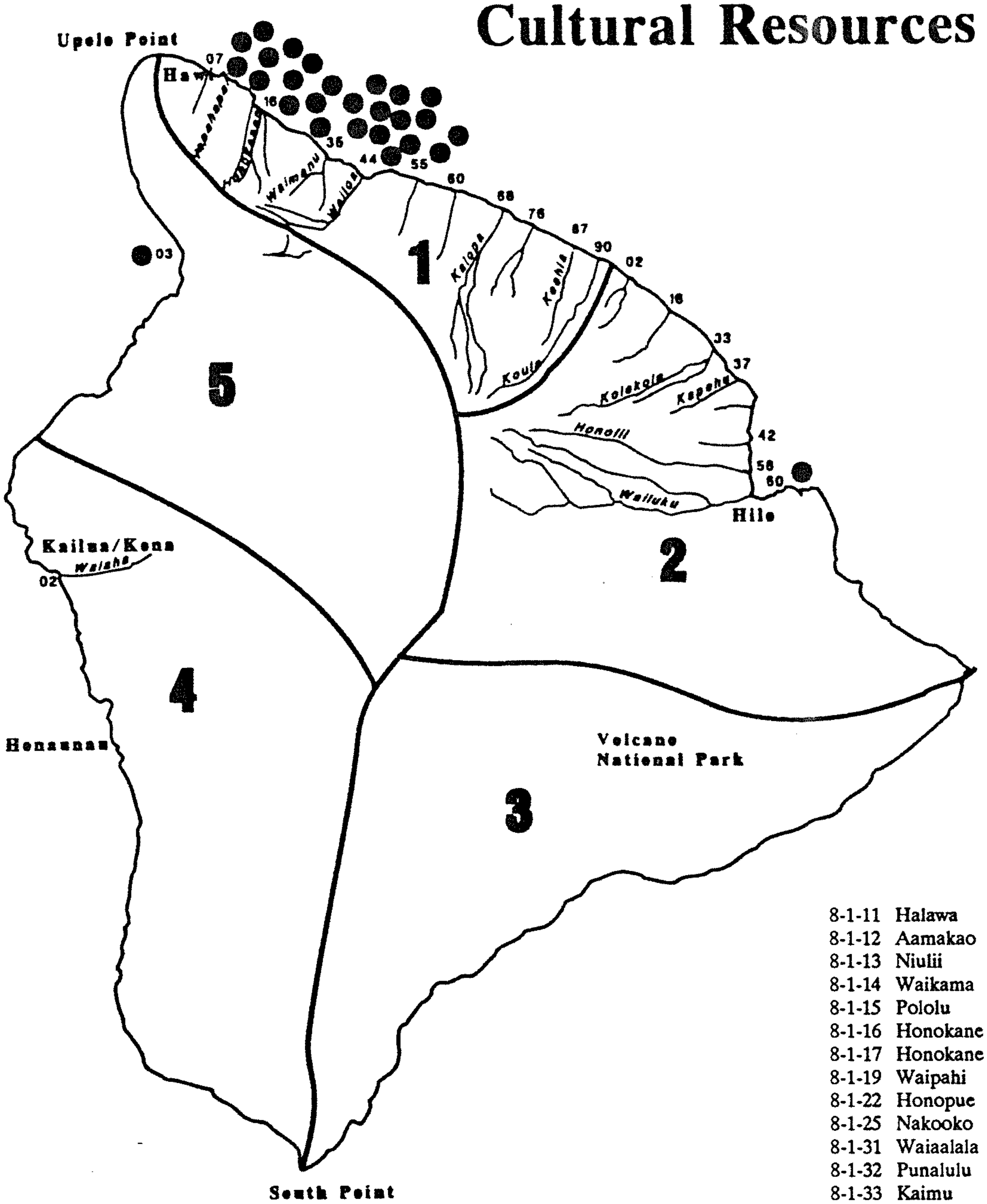
MAUI

Island Code - 6

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Map 6
Outstanding Cultural Resources



8-1-11 Halawa
8-1-12 Aamakao
8-1-13 Niulii
8-1-14 Waikama
8-1-15 Pololu
8-1-16 Honokane Nui
8-1-17 Honokane Iki
8-1-19 Waipahi
8-1-22 Honopue
8-1-25 Nakooko
8-1-31 Waiaalala
8-1-32 Punalulu
8-1-33 Kaimu
8-1-34 Pae
8-1-35 Waimanu
8-1-44 Wailoa/Waipio
8-1-45 Lalakea
8-1-46 Kaluahine Falls
8-1-47 Waiulili
8-1-49 Waipunahoe
8-1-50 Waialeale
8-1-51 Waikoloa
8-1-52 Kapulena
8-1-53 Kawaikalia
8-1-54 Malanahae
8-2-61 Wailoa R.
8-5-03 Waikoloa

HAWAII
Island Code - 8

Hawaii Stream Assessment

Note:	Only a portion of the total number of streams are depicted on this map.

Recreational Resources

Water-related recreation is a part of life in Hawaii. Although beaches draw more users, stream-related recreation is also significant. It includes water-based activities such as boating and swimming, land-based activities such as hiking and camping, and less energetic ventures such as nature study or sightseeing. This is the first attempt to inventory and assess stream-related recreation in Hawaii.

A state Recreational Resources Committee was formed to design the recreation inventory and assessment. Members identified boating, camping, fishing, hiking, hunting, nature study areas, scenic views, public parks and swimming as the elements to be included in the inventory. They next identified two basic sources of information: 1) government documents and other published information such as guide books and maps; and 2) residents who were familiar with local recreational opportunities.

Regional committees were then established on each island and given responsibility for compiling an inventory for their respective islands, based on current uses and facilities. Members included representatives from state and local governments, hunting clubs, longtime residents, recreational user groups, and other members of the public who responded to a call for participation issued by HSA.

Island by island recreational inventories were then developed, using a modified U.S. Forest Service Recreation Opportunity Spectrum, or ROS classification. Assessment factors used to rank the streams were diversity of experiences, quality of the experiences, specific unique characteristics, and unique combinations of attributes. The regional committees ranked all streams for their islands as Outstanding, Substantial, Moderate and Limited/Unknown. Based on the list of 70 regionally outstanding streams, the state committee, using regional input, identified 18 outstanding streams statewide. Five of these are on Kauai, two on Oahu, three on Molokai, three on Maui and five on Hawaii. Several of these "streams" are actually large stream systems.

The results of this inventory and assessment are somewhat subjective in that they are related to the composition of the committees and their collective experiences. In addition, the inclusion of an experience in this study does not necessarily mean that it is one the general public can take advantage of. Rather it means only that it was identified by some user. Finally, this report should not be considered a complete and final inventory of stream-related recreational resources.

Background

Recreation has been assessed in many other states through processes similar to the HSA. Water-based activities (fishing and boating) are dominant or equal to land-based activities in most states but Hawaii is quite different. Hawaii's streams are relatively short, narrow, and shallow by continental standards. Swimming is common but boat-related activities are considerably limited. Kayakers cannot explore even the largest streams for more than a mile or two. Sport fishing is extremely limited because of the small number of species and their somewhat limited distribution. As a consequence, stream-related recreation is primarily land-based.

Outrigger canoe paddling may be the only uniquely Hawaiian stream-related recreational resource. Canoe clubs often use Hawaii's larger streams for practice and staging, especially during inclement weather.

Methods

Committee

The State Recreational Resources Committee consisted of people involved with recreation through state government, educational and outdoor groups.

After identifying the elements to be included in the inventory and assessment, the state Recreational Resources Committee looked to two sources for primary information. First were government documents and other published information, such as guidebooks and maps. Second were local residents familiar with recreational opportunities on each island.

Regional committees were established on each island to gather information on local recreational uses. Regional chairs were recruited by the state committee. Their first job was to identify and convene a representative group of recreational users on their islands, who would then conduct the preliminary inventories and assessments. The State Recreational Resources Committee wanted each regional committee to include representatives from a broad spectrum of recreational users -- hiking groups, hunting clubs, longtime local residents who used streams for a variety of purposes -- as well as members from state and county agencies. Participation from the public at large was also solicited through a press release issued by the HSA.

Recreational Resources Committees
STATE

Chair, Patty Kupchak, Sierra Club
Lorin Gill, Moanalua Gardens Foundation
Eric Onizuka, DLNR Aquatic Resources
Wayne Souza, DLNR Parks and Recreation

Oahu

Chair, John Hall, Hawaiian Trail and Mountain Club
Richard Davis, Hawaiian Trail and Mountain Club
John Clark, Ocean Recreation Consultant
Lorin Gill, Moanalua Gardens Foundation
Bill Gorst, DLNR Parks and Recreation
Mabel Kekina, Hawaiian Trail and Mountain Club
Steve Rohrmayer, Pig Hunters Association
Jason Yuen,City and County of Honolulu, Parks and Recreation

Molokai

Co-Chair, Mary Place
Co-Chair, Jo-An Salmon
Cliff Soares, Molokai resident
Dan Kuhns, Molokai resident
Bill Puleloa, DLNR Aquatic Resources

Kauai

Chair, Tom Telfer, DLNR Forestry and Wildlife
Chico Godinez, Kayaks Kauai
Micco Godinez, Kayaks Kauai
Bob Hee, Garden Island Shooting
Glenn Ikemoto, Light Tackle Anglers of Kauai
Kanna Smyth, DLNR Division of State Parks
Kathy Valier, Sierra Club
Ernest Ventura, Garden Island Archery Club

Maui

Co-Chair, Anne Fielding, The Nature Conservancy
Co-Chair, Mike Minn, Hana Community Association
David Brown, Sierra Club
Joe Harabin, Maui resident
Skippy Hau, DLNR, Aquatic Resources
Garrett Hew, East Maui Irrigation Company
Bob Hobdy, DLNR Forestry and Wildlife
Sadao Yanagi, Maui resident

Hawaii

Chair, Chris Yuen, Sierra Club
Gretchen Grove, Hawaii resident
Cathy Lowder, Sierra Club
Bob Nishimoto, DLNR, Aquatic Resource
Quentin Tomich, Conservation Council
Joe Wierschem, Sierra Club

Members of the regional committees met to augment the published information with their personal knowledge of the recreational resources on their islands. The state chair and at least one member of the study team attended meetings to provide specific direction and maintain consistency. All information was recorded on specially prepared datasheets (Table 39). This information served as the primary data source. When a lack of information about a certain activity or region was identified, specific resource people were called upon to provide information.

The data were compiled and reviewed by the regional committee chairs and then sent on to the state committee for additions and final approval. Then, the streams were assessed using the regional criteria and, in a very few cases, adjusted by the regional committees. The final list of regionally Outstanding streams was used as the candidate list for statewide Outstanding. Finally, the state committee determined statewide Outstanding streams, based on the work by the regional committees. These inventory and assessment methods are discussed in the next section.

Inventory

Opportunity Types

All recreation opportunity types initially considered stream-related were inventoried based on current usage or facilities. These were boating, camping, fishing, hiking, hunting, nature study areas, scenic views, public parks and swimming.

Boating: Canoeing, kayaking, windsurfing and motorized boating were inventoried.

Camping: All authorized camp sites as well as frequently used camping areas were included.

Fishing: Fishing for and/or taking of introduced or native fresh-water or marine (estuarine) species and, on Kauai, frogging were placed in this category. Both "serious" fishing and neighborhood children "fishing" from bridges were included.

Hiking: All hiking trails identified by the recreation committee as stream-related were entered. This includes maintained hiking trails, local "unimproved" trails, dirt roads, and jogging routes in urban areas. Stream-related trails are those leading to streams, paralleling streams and trails in which a view of the stream is important.

Hunting: Hunting areas were identified by the committee and may not necessarily be those shown on DLNR's hunting maps. This inventory includes hunting for pigs, goats, deer and game birds.

Nature Study Areas: Nature study areas include botanical gardens adjacent to a stream and established educational programs that either have a facility adjacent to a stream or a published guide to a stream.

Parks: Public parks that encompass portions of, or are adjacent to streams and managed by the counties, the state or the National Park Service were inventoried.

Scenic Views: Scenic views (of waterfalls and scenic valleys, etc.) from the road, ocean, air and trail are included. Roads requiring four-wheel drive vehicles were recorded as trails.

Swimming: All swimming holes identified by the committee were recorded. The regional committee on Hawaii determined that surfing at stream mouths on the island of Hawaii should be included in this category. The committee argued that these sites, created by shoals formed at stream mouths, were an important resource due to the limited reef-associated surfing sites on that geologically young island.

Classifications

Each of these opportunity types was classified according to a Recreational Opportunity Spectrum (ROS). Then, each was rated according to the quality of experience it afforded.

Recreational Opportunity Spectrum: This classification was developed by the U.S. Forest Service to provide a framework for the collection and evaluation of recreation inventory data (USFS 1978). It allows the user to distinguish among the variety of experiences associated with outdoor recreation in different settings. The state committee adapted the original categories for use in the Hawaii Stream Assessment.

After the opportunity types were identified, they were categorized as Urban, Country, Semi-Natural and Natural. Each of these combinations is a field in the database.

Urban/Suburban: This is where most people live and work. Buildings and paved roads dominate. Recreational places are often city or county parks with exotic plants and mowed lawns. Non-recreational uses may dominate.

Country/Rural: Small outlying communities with open space and often cultivated land. Recreational areas are often county or state parks, or large campgrounds. Recreational facilities may be common and include cooking grills and restroom facilities. Non-recreational uses may be present but not as common or as intrusive as on urban streams.

Semi-Natural: The settings are more remote, away from the main traveled highways. Access may require a 4-wheel drive vehicle. Facilities may be present at parks but are not present elsewhere. Surrounding vegetation/forest has been highly altered by previous use or intrusion of introduced species.

Natural: These are the most remote settings, where fewer people go. Often the settings are completely away from the sights and sounds of people. Facilities and non-recreational resource uses are scarce or absent entirely. Hiking trails (generally the only access) leading to these areas are long and often difficult. The vegetation has a high proportion of native species and/or is relatively pristine.

By combining the recreational opportunity category (e.g., boating or hiking) with the setting category (eg., urban/suburban or natural) recreational experiences could be rated and compared, while holding subjective qualitative judgments to a minimum. Boating on the Ala Wai Canal and the Hanalei River may both be high quality experiences, for example, but cannot be compared with each other. However, boating on the Huleia and the Hanapepe Rivers, both rural locations, can be more objectively compared.

Quality: Each identified experience was then assigned a quality class, common or high quality. A high quality experience is one of the best of its type on that island. All those determined to be of high quality were described detailing the outstanding feature.

Descriptors

Descriptions of high quality experiences, access problems, detractions, local importance, unique characteristics and potential for improvement were also collected and noted in database comment fields.

High Quality Experience: A description of each high quality experience was requested from the committees.

Access: The inventory includes all recreational activities on Hawaii's streams regardless of restrictions in access. Conditions noted are closed private land, private access available through waiver, and restricted access.

Detractions: Detractions such as litter, inadequate facilities, overuse, helicopter noise, pollution, leptospirosis contamination, flash flooding, or artificially diminished flow were noted, especially when they served to downgrade the inventory ranking from high quality to common.

Local: Streams with great local but not necessarily island or state importance were noted in the inventory. Local experiences are important to the quality of life in certain areas and therefore their identification could be useful for county planning.

Unique: This category allowed the committee to directly rank a stream as outstanding based on features it considered to be of such value or scarcity on an island or statewide that the stream should be considered outstanding regardless of the lack of other quality characteristics or experiences. A description of the features was required in the comment field.

Potential: A stream with potential is defined as one that would be outstanding if restoration, public access, acquisition, protection, regulation, or recreational development took place. A description of the needed action was required.

Assessment

The committee developed a two-step assessment process: 1) regional assessment, and 2) state assessment. This process made the task of assessing 376 streams manageable. It also created separate regional inventories and assessments which are useful tools for county-level planners. Both regional and state assessments were based on the following general factors:

- Diversity of experiences;
- Unique characteristic (scarcity);
- Quality of experience;
- Unique combination of attributes.

Regional Assessment Methods

The inventory data was tallied for each of the 500 streams and tributaries; however the assessment was based on only the 376 streams finally determined to be perennial.

Number of High Quality Experiences: The number of high quality experiences (opportunities within any of the ROS settings -- Urban, Country, Semi-natural, Natural) was inventoried.

Total Number of Experiences: The total number of experiences high quality or common, was inventoried.

Potential or Unique: Streams with unique characteristics and those with potential were also noted.

The state committee assigned preliminary Outstanding, Substantial, Moderate, and Limited/Unknown rankings to streams based on the regional assessment criteria. Some regional committees were more generous in assigning high quality experience rankings than others. Consequently, some subjective adjustments were made by the state committee such that the number of high quality experiences required for an Outstanding stream varied island by island. This information was sent to the regional committee members for review and correction.

Regional Recreation Assessment Criteria

Outstanding:	Diversity of high quality experiences, unique characteristic, or a unique combination of attributes. Streams with potential to become Outstanding through restoration, acquisition, protection, regulation, or facilities development were also included.
Substantial:	Diversity of experiences or some experiences of high quality
Moderate:	Several experiences but none of high quality.
Limited/ Unknown :	No experiences were identified or the recreational experiences are unknown.

State Assessment Methods

The next step required the regional committees to compare the resources on their island to resources statewide. All of the streams rated Regionally Outstanding or Regionally Potentially Outstanding were placed on the candidate list for Statewide Outstanding and sent to the 35-plus committee members. The state ranking criteria for outstanding were defined as diversity of experiences, high quality experiences, unique characteristics, or a unique combination of attributes.

State Recreational Resource Assessment Criteria

Outstanding:	Diversity of experiences, high quality experiences, unique characteristic, or a unique combination of attributes.

The regional committees were asked to choose their top 10 streams, including no more than five from any single island, and then to choose their next 15 top streams, including no more than seven from any single island. This was to be based on the information provided to them and their own knowledge.

The assessments were straightforward with the exceptions of Kauai and Molokai. Kauai, in addition to choosing 25 Outstanding streams as requested, named nine more they felt were worthy of "Honorable Mention." Committee members felt their island had so many great streams that they should not be restricted by the 25- stream limit and the geographic distribution requirement. The state committee noted that the relatively old geologic age of Kauai has resulted in a greater number of larger and better developed streams. Based on that, the state committee accepted these "Honorable Mentions" and awarded them the same rank as the second 15. The Molokai committee did not feel qualified to rank any streams on other islands so they limited their assessment to Molokai streams.

This information was compiled and sent back to the state committee for the final determination of state Outstanding and other important streams statewide.The State Recreation Committee reviewed the outstanding ranks awarded by the regional committees and determined that any stream that was selected in the top 10 by that island's committee would be declared Outstanding (Table 37).

Results

Inventory

Table 34 shows the number of streams with various activities and the number of experiences within each activity type. The first line for each island shows the number of streams with at least one opportunity type. The second line shows the actual experiences recorded. For example, 45 streams on Kauai were recorded as having scenic value, whereas 109 scenic experiences were noted (some from each of the vantage points, trail, air, ocean and road). Similarly, 39 streams on Oahu were recorded as having some sort of swimming holes whereas 42 swimming experiences were recorded — thus, at least a few streams had swimming holes in more than one ROS area. Hunting data were intentionally excluded from this table because the activity was determined to be only indirectly stream-related.

Only 31 boating experiences were identified statewide. In contrast, there are approximately 200 experiences each for fishing, hiking or swimming statewide. Half of all of the boating experiences are on Kauai, while none were identified on Maui. These few experiences are due to the short length of Hawaii's streams and is illustrated by the fact that boating only encompasses one ROS category, either urban or country.

Camping opportunities near streams appear to be limited on Maui and Molokai. Stream- related hiking opportunities seem to be relatively evenly distributed throughout the state. Fishing takes place on all islands, but on Hawaii it appears to encompass more than one ROS more often than on other islands. Fishing experiences were fairly well distributed around the state except for the limited experiences on Molokai.

There are only a few stream-related parks on Molokai, Maui and Hawaii, while there are a number of them on Oahu and Kauai. The numbers do not represent the number of different parks since in some cases one park is associated with many individual streams (such as the Na Pali State Park and Kokee State Park on Kauai). Only Kahana State Park on Oahu and Iao State Park on Maui encompass more than one ROS. That may be due partly to the relatively short nature of our streams but is also indicative of the small size of most of our stream-related parks.

Only 20 stream-related nature study areas were identified statewide. Most of these are botanical gardens, and most are on Oahu. Educational programs are also included in this category. These are Kahana and Makiki on Oahu, Kolekole on Hawaii, and Iao, Waikapu and Maliko on Maui. The lack of educational materials on streams has been noticed and is being addressed by the Ohia Project. In this project, the Bishop Museum and Moanalua Gardens Foundation are working with the State Department of Education to develop ecological educational curriculum and materials to integrate into regular lessons for grades K-8. Students participating in the Ohia Project will learn about streams through field trips. This important nature study program will be linked to specific streams in the near future.

All of the neighbor island committees ranked their streams as more scenic than the Oahu committee did. Furthermore, neighbor island committees ranked many of their streams scenic from more than one viewpoint. The less developed parts of the islands, such as the north shore of Molokai, the north Kohala and Hamakua coasts of Hawaii, the Hana area of Maui and the Na Pali coast of Kauai, accounted for many of these scenic ratings.

Table 34. Distribution of Selected Recreational Experiences	Boat	Camp	Fish	Hike	Swim	Park	NatStdy	View
Kauai								
Streams	16	24	47	42	39	31	3	45
Experiences	16	28	59	48	48	31	4	109
Oahu								
Streams	9	18	53	37	39	33	10	21
Experiences	9	20	63	38	42	34	12	28
Molokai								
Streams	1	8	10	10	13	5	0	25
Experiences	1	12	16	15	20	5	0	50
Maui								
Streams	0	8	42	54	54	4	4	51
Experiences	0	9	51	66	60	5	5	124
Hawaii								
Streams	5	20	63	42	44	9	2	82
Experiences	5	20	125	49	47	9	2	189

The Recreational Opportunity Spectrum allows analysis of a different sort. By viewing opportunity types through this spectrum, one can see the range of experiences available. It is a recreational management tool that helps assure that the broadest range of the public has access to the quality of recreation experiences they seek. The following table shows the number of streams with one or more experiences in a particular recreational opportunity spectrum setting for each island. Parks and hunting were excluded from this tally because parks often encompass more than one stream and hunting was determined to be only indirectly related to streams. Scenic view were also excluded as they were not classified using the ROS.

Table 35. Recreation Opportunity Spectrum Distribution	Urban	Country	Semi-Natural	Natural
Kauai	3	34	45	9
Oahu	24	32	37	3
Molokai	0	7	13	8
Maui	0	56	42	2
Hawaii	3	37	72	50

Streams with natural experiences were rare on all islands except Hawaii. Molokai has a deceivingly large percentage of streams with experiences in the natural area. Three of the streams with natural experiences refer to experiences in the headwaters of the Kamakou Nature Conservancy Preserve. Others are located in the Pelekunu Nature Conservancy Preserve. Combined, half of all natural experiences are in TNC preserves. Most of the natural experiences on Kauai were on tributaries of the Waimea River in the Kokee area, the rest on the Hanapepe and Wahiawa Rivers. (Streams on Kauai's Na Pali coast were not considered natural due to the abundance of non-native vegetation.) On Hawaii, 42 of the 50 streams with natural experiences involved only fishing opportunities on Hamakua Coast streams. The other eight streams with natural experiences were in North Kohala and on the Wailuku River.

Few urban experiences were identified on the mostly rural outer islands while only three streams with natural experiences were recorded on the heavily urbanized island of Oahu. These were Kaluanui and Makaua and Kiikii System (Kaukonahua Stream).

Descriptive information was collected as committees inventoried the recreation experiences. However, since only high quality experiences required descriptions, the information is not summarized in tabular form.

Access was mentioned as a problem on all islands, but only the Oahu and Kauai regional committees noted access problems on specific streams. Access was perceived to be such a problem for the Maui group that they did not always mention it stream by stream. A permit is required to visit portions of any stream between Kahului/Wailuku and the outskirts of Hana on East Maui and all except three streams on West Maui (Iao, Waihee, and Makamakaole).

In many less developed areas of the state, it is local custom to allow general access to a stream across private property. The committees on Molokai and Hawaii reported few current access problems but noted that as population and development increase, this local custom may disappear. As a result, these committees identified several streams to which they felt public access should be maintained. Examples include streams along the Kohala Ditch trail and Waialua on Molokai.

Helicopter noise is perceived as a particular problem on the north shore of Kauai and the Hana area of Maui. Other detractions mentioned by the committees include litter, overuse, poorly maintained and/or hazardous road and trail access to the stream, vandalism of parked cars, marijuana growing, military maneuvers, and various developments (hydroelectric, golf course, highway).

Leptospirosis contamination of a few streams was mentioned, although the State Department of Health considers it to be a problem on all streams in Hawaii.

"Overuse," a perception based on what one expects an experience to be, was used with reference to Kalalau Stream on Kauai's Na Pali Coast, yet not the Ala Wai Canal.

Locally important swimming holes were the main experience identified by all committees. This special descriptive category was not used in the assessment but was included because of its value to county planning.

Streams with potential to be outstanding were identified by all regional committees. Actions recommended include improving public access, better management of park areas, trail development on public lands, and the cleaning up of streams. In several cases, proposals (Na Ala Hele's plan for demonstration trails at Maunawili, Oahu and Waioli, Kauai, and state plans for recreational development of the upper Hanalei, Kauai, and Alu Like's plans for Makamakaole, Maui) and unimplemented plans (urban greenways along Oahu's Nuuanu and Manoa streams) led committees to identify streams as having potential.

Unique streams were identified by all regional committees. Specific geologic or stream features and the scarcity of a recreational resource in a particular area were the most common reasons for describing a stream as unique.

Assessment

Regional Assessment Results

The following table shows the number of streams ranked in each category by island.

Table 36. Distribution of Regional Assessment Ranks

	Outstanding	Substantial	Moderate	Ltd/Unknown	Total
Kauai	17	19	15	10	= 61
Oahu	7	30	15	5	= 57
Molokai	7	11	11	7	= 36
Maui	22	36	14	18	= 90
Hawaii	17	50	49	16	= 132
Total	= 70	= 146	= 104	= 56	= 376

State Assessment Results

The 70 Regionally Outstanding streams are shown on Map Set 7.

Table 37. Statewide Outstanding Streams for Recreation

Kauai

2-1-10 Hanakapiai
2-1-18 Waioli
2-1-19 Hanalei
2-2-08s Wailua System
2-4-04s Waimea System

Oahu

3-1-18 Kahana
3-6-06s Kiikii System

Molokai

4-1-15 Wailau
4-1-21 Halawa
4-2-04 Waialua

Maui

6-2-07 Waihee
6-2-09 Iao
6-5-13 Oheo

Hawaii

8-1-16 Honokane Nui
8-1-35 Waimanu
8-1-45 Lalakea
8-2-33 Kolekole
8-2-60 Wailuku

Discussion

Much land use planning is done island by island rather than statewide so that the regional assessment of streams is very important. It includes streams that are not only currently outstanding but also those that have the potential to be outstanding. Streams ranked regionally outstanding for recreation warrant consideration by local parks departments for recreational development and should receive extra scrutiny when non-recreational developments are proposed.

Streams that received votes from more than two regional committees are clearly significant. However, name familiarity may indirectly be a factor in the identification of these streams. Many of the streams that have associated state or national parks or wildlife refuges are on the list, as are those that have been the topic of public controversy. Parks and refuges are clearly identified and promoted for their facilities, educational opportunities and, indirectly, for the access they provide. Streams that have been in the public eye may be brought to the attention of the recreational user who then plans a visit.

The statewide outstanding streams are those considered the most outstanding by residents of that island. These streams deserve special protection and consideration for recreational development. Many of these streams are now associated with parks and those that aren't should be considered for park development, after giving due consideration to their aquatic and riparian resources.

Streams ranked highly for recreation tend to be correlated with high flow rates, and to a lesser extent with stream length. All of the largest 25 streams were ranked either Outstanding or Substantial. Only three of the 50 largest streams for which gaging data is available were ranked Moderate: Waikele, Oahu; Hapuaena, Maui; and Nailiilihaele, Maui. All except six streams of the 50 that are 10 miles or longer (based on the U.S. Army Corps of Engineers Headwaters survey), were ranked outstanding or substantial on the regional ranking scale.

Boating and natural experiences are rare throughout the islands. Streams with these resources tend to be included in the list of outstanding and important streams.

Hunting was initially considered stream-related, but later that relationship was questioned. Hunting may occur along a stream, but the quality of the experience is not directly affected by the stream. It is rather related more to the abundance of animals, physical access, and other factors. In addition, hunting is often incompatible with other stream-related recreational activities.

Limitations to Inventory

The methodology used to create this inventory is by its nature subjective and dependent on the individual members of the committee and their experiences. The regional committee chairs were nominated by the state committee from among their personal and professional acquaintances. Then, these regional chairs chose their own members using state committee guidelines. Others were identified through HSA press releases. The committees, as a result, differed in composition, expertise and size. A different committee may or may not have arrived at the same results.

The experiences available on a particular stream might be under-represented in some cases and over-represented in others. Each of the streams was inventoried and that information recorded on a datasheet. The datasheet allowed for only one opportunity-type within any one recreational opportunity spectrum. A stream that has, for example, two semi-natural camping experiences will only be counted once and therefore may be under-represented. Sometimes one physical feature can be overrepresented. One waterfall can be counted as scenic from all four vantage points and would receive four "points". Other streams that would also receive four points might have hiking, camping, swimming and fishing. Whether these are equivalent is debatable. The length of the stream and the number of recreational opportunity spectra it encompasses also affected its ranking. For example a stream which goes through several ROS's has more chance to be ranked than a stream that only flows through "Country".

As previously indicated, this inventory includes all recreational activities that take place on Hawaii's streams regardless of public access. No detailed location information was collected nor any specific mapping undertaken.

Limitations to State Assessment Results

This assessment is by nature subjective. However, the validity and reliability of the process are considered adequate due to the breadth of the recreation committees' collective experiences and opinions. In other words, the streams categorized Outstanding statewide are probably inclusive of all of the truly great recreational streams, but it is possible that some may have been overlooked or that some have been ranked higher than they should have been.

Neither the state chair nor the study team attended the second meeting of the regional committees. Therefore the criteria used were not necessarily consistently interpreted. In fact, each regional committee did things a little differently. For example, the Maui committee felt that the amount of use was an important positive factor and therefore based its decision on this in addition to the ranking criteria provided.

The state committee arbitrarily decided to allow each regional committee to choose a maximum of five streams for the statewide outstanding list from their island. Five seemed like a reasonable number but using a percentage approach (25 percent) could have been more useful. The Kauai committee felt strongly that they had so many outstanding streams that they awarded additional streams "Honorable Mention" status. The state committee accepted these additional "votes" even though this option was not presented to the other regional committees. They reasoned that Kauai had a greater number of better developed streams.

Future Research

The Hawaii Stream Assessment was designed to obtain a broad overview of Hawaii's stream-related resources. While there are considerable benefits to such a study, a more in-depth survey could yield other useful results. A follow-up review of Hawaii's recreational resources could:

Refine the definition of stream-related recreational resources. What are stream-related recreational resources and how do people use them? Have all the appropriate opportunities been inventoried?

Are there other general areas that should or should not have been included? Should all of the opportunities be combined and given equal weight or are some more important than others?

What kinds of information should be collected with regard to these opportunities? Should information be collected on resources accessible to only a few along with those accessible to the many? How do people use these resources? Are the areas HSA identified exclusive or inclusive? How can recreation be measured at all?

Develop more objective evaluation criteria. In the HSA survey, committee members were asked to consider "where they would most like to go" as the criterion for a high quality resource. Better standards than this should be developed and employed.

Develop data collection processes that have increased reliability. Assuming that the regional committee approach is the best approach, it might be possible to set up regional committees whose members have similar profiles. How does one identify good resource people? Would committee members intentionally skip over or underrate a resource to protect it from over exploitation? Can accurate data be obtained?

More interaction with these hand-picked committees would allow for a more exhaustive search for information. The short-term commitment required by the Hawaii Stream Assessment's process may have increased the willingness of some busy people to participate, but more follow-up might result in more comprehensive information.

Other future research might include identification of streams to be targeted for recreational development. Criteria might take into account conflicts with other resources, geographic distribution, availability to urban populations and predictions of future recreational needs.

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Table 38 Recreational Resources

CODE HSA code; Island-hydrographic unit-stream (system)

STREAM Stream name at mouth

OPPORTUNITIES

C	camping	H	Hiking
F	Fishing	S	Swimming
B	Boating	U	Hunting
N	Nature Study	V	Scenic Views
P	Parks		

EXP Number of experiences (opportunities categorized by Recreational opportunity spectrum. * Number could not be calculated for stream systems.

PLUS Number of high quality experiences. * Number could not be calculated for stream systems.

REG Rank assigned to the stream by the regional committee

1	Outstanding	2	Substantial
3	Moderate	4	Limited
P	Potential		

REG Rank assigned to the stream by the regional committee

STATE Statewide Outstanding streams

1 Outstanding

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
Kauai						
2-1-01	Awaawapuhi	HFSPUV	8	1	2	
2-1-02	Honopu	SPUV	5	0	2	
2-1-03	Nakeikionaiwi	CHFSPUV	10	3	1	
2-1-04	Kalalau	CHFSPUV	9	9	1	
2-1-05	Pohakuao	HSPUV	6	1	2	
2-1-06	Waiolaa	HSPUV	6	0	2	
2-1-07	Hanakoa	CHFSPUV	8	6	1	
2-1-08	Waiahuakua	HPUV	6	4	2	
2-1-09	Hoolulu	HPUV	6	4	2	
2-1-10	Hanakapiai	CHFSPV	8	5	1	1
2-1-11	Maunapuluo	HPV	4	0	3	
2-1-12	Limahuli	HSNV	7	2	2	
2-1-13	Manoa	CPUV	5	0	2	
2-1-14	Wainiha R.	CHFSBUV	8	3	1P	
2-1-15	Lumahai R.	CHFSBUV	7	2	2P	
2-1-16	Waikoko	V	1	0	3	
2-1-17	Waipa		0	0	4	
2-1-18	Waioli	HFSBUV	9	3	1P	1
2-1-19	Hanalei R.	CHFSBPUNV	15	8	1P	1
2-1-20	Waileia		0	0	4	
2-1-21	Anini		0	0	4	
2-1-25	Kalihiwai R.	CHFSBUV	8	2	2	
2-1-26	Puukumu	V	1	1	2	
2-1-27	Unnamed		0	0	4	
2-1-28	Kilauea	CHFSBUV	10	8	1P	
2-1-29	Kulihaili		0	0	4	
2-1-30	East Waiakalua	F	1	1	2	
2-1-31	Pilaa	F	1	1	2	
2-1-32	West Waipake	F	1	1	2	
2-1-33	East Waipake	CHFU	4	3	2	
2-1-34	Moloaa	U	1	0	3	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
2-1-35	Papaa		0	0	4	
2-1-36	Aliomanu		0	0	4	
2-2-01	Anahola	FSBUV	7	0	2	
2-2-02	Kumukumu		0	0	4	
2-2-04	Kapaa	HFSBUV	8	1	1	
2-2-05	Moikeha Canal	FS	2	0	3	
2-2-06	Waikaea Canal	FSBP	4	0	2	
2-2-08s	Wailua System	CHFSBPUV	0	0	1	1
2-2-10	Kawailoa	F	1	0	3	
2-2-12	Hanamaulu	CFBPV	5	0	2	
2-2-13	Nawiliwili	SPNV	4	0	3	
2-2-14	Puali	CFP	3	0	3	
2-2-15	Huleia	HFSBPUV	10	3	1	
2-3-01	Kipu Kai	CHUV	6	6	2	
2-3-02	Waikomo	HPUV	4	0	3	
2-3-04	Lawai	HFSUNV	9	4	2	
2-3-06	Wahiawa	HFSUV	7	5	1	
2-3-07	Hanapepe	HFSBUV	14	8	1P	
2-4-01	Mahinauli	U	1	0	3	
2-4-02	Aakukui	U	1	0	3	
2-4-03	Waipao	U	1	0	3	
2-4-04s	Waimea System	CHFSUUBPV	*	*	1	1
2-5-06	Kinekine Ditch		0	0	4	
2-5-07	Kaawaloa		0	0	4	
2-5-08	Nahomalu	U	1	1	3	
2-5-09	Kaulaula	U	1	1	3	
2-5-10	Haeleele	U	1	1	3	
2-5-13	Kauhao	U	1	1	3	
2-5-15	Milolii	CHFSPUV	9	2	2	
2-5-16	Nualolo	CHFSPUV	9	5	1	
		Oahu				
3-1-03	Paumalu		0	0	2	
3-1-04	Kawela		0	0	4	
3-1-05	Oio	U	1	0	3	
3-1-06	Malāekahana	HU	2	0	3	
3-1-07	Kahawainui	CFSPU	6	0	2	
3-1-08	Wailele Gl.		0	0	4	
3-1-09	Koloa Gl.	CHSPUV	6	3	1	
3-1-10	Kaipapau	SU	2	0	2P	
3-1-11	Maakua	CHFSPV	6	2	1	
3-1-13	Kaluanui	CHFSPUV	11	4	1	
3-1-16	Punaluu	CHFSPU	8	0	2	
3-1-18	Kahana	CHFSBPUNV	14	10	1	1
3-1-19	Kaaawa	FPU	3	0	2	
3-1-20	Makaua	HV	2	0		
3-1-21	Unnamed		0	0		
3-2-01	Hakipuu		0	0		

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
3-2-02	Waikane	HFSPU	6	0	2	
3-2-03	Unnamed	S	1	0	3	
3-2-04	Waiahole	CHFSU	6	0	2	
3-2-05	Kaalaea	UN	2	0	3	
3-2-07s	Kahaluu S.	FSBPU	0	0	2	
3-2-08	Heeia	FSU	4	0	2	
3-2-09	Keaahala	F	1	0	3	
3-2-10	Kaneohe	CHFSPNV	8	0	2	
3-2-11	Kawa	S	1	0	3	
3-2-13	Kawainui/Maunawili	FBP	3	0	2	
3-2-14	Kaelepulu Canal	FSBP	4	0	2	
3-2-15	Waimanalo	CFPU	4	0	2	
3-3-03	Kuliouou	HFPU	4	0	2	
3-3-04	Niu	HFU	3	0	2	
3-3-05	Wailupe	HFPU	4	0	2	
3-3-06	Waialaenui	HFPU	4	0	2	
3-3-07s	Ala Wai System	HSUNBVPF	*	*	1	
3-3-09	Nuuanu	HFSPUNV	8	2	2P	
3-3-10	Kapalama	FN	2	0	3	
3-3-11	Kalihi	FSU	3	0	3	
3-3-12	Moanalua	HFSPUNV	7	1	2	
3-4-02	Halawa	HFSU	4	0	2	
3-4-03	Aiea	FP	2	0	3	
3-4-04	Kalauao	HFSUV	5	1	2	
3-4-05	Waimalu	CHFSPUV	7	1	2	
3-4-06	Waiawa	HFSU	4	0	2	
3-4-10	Waikele	FP	2	0	3	
3-4-11	Honouliuli	F	1	0	3	
3-5-01	Nanakuli	CFSPU	5	0	2	
3-5-02	Ulehawa	FSPU	4	0	2	
3-5-04	Mailiili	FSPU	4	0	2	
3-5-05	Kaupuni	CHFPUNV	8	2	2	
3-5-07	Makaha	FPUV	6	2	2P	
3-5-08	Makua	F	1	0	3	
3-6-03	Unnamed		0	0	4	
3-6-04	Makaleha	UV	2	0	3	
3-6-06s	Kiikii System	CHFSBPUV	*	*	1	1
3-6-07s	Paukauila System	CHFBSUV	*	*	2	
3-6-08s	Anahulu System	CHFBSUV	*	*	1	
3-6-09	Loko Ea	CP	2	0	3	
3-6-10	Waimea R.	HFSPN	5	0	2	
		Molokai				
4-1-01	Waihanau	PUV	4	2	2	
4-1-02	Waialeia	PUV	4	2	2	
4-1-03	Waikolu	CHPUV	6	3	1	
4-1-04	Wainene	PV	3	0	3	
4-1-05	Anapuhi	V	2	2	2	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
4-1-06	Waiohookalo		0	0	4	
4-1-07	Keawanui	V	2	0	3	
4-1-08	Kailiili	C	1	0	3	
4-1-09	Pelekunu	CHFSUV	12	12	1	
4-1-10	Waipu	V	2	0	3	
4-1-11	Haloku	V	2	2	2	
4-1-12	Oloupena	V	2	2	2	
4-1-13	Puukaoku	V	2	2	2	
4-1-14	Wailele	CV	3	0	2	
4-1-15	Wailau	CHFSUV	13	13	1	1
4-1-17	Waiahookalo	CHFSUV	13	9	1	
4-1-18	Kahiwa	V	2	2	2	
4-1-19	Kawainui	V	2	2	2	
4-1-20	Pipiwai	V	3	1	4	
4-1-21	Halawa	CHFSBPUV	15	7	1	1
4-1-22	Hakaano	CFS	5	3	3	
4-2-01	Pohakupili		0	0	4	
4-2-02	Honoulimaloo	S	1	0	3	
4-2-03	Honouliwai	SUV	3	1	2	
4-2-04	Waialua	HFSUV	7	4	1	1
4-2-05	Kainalu	S	1	0	3	
4-2-06	Honomuni	S	1	0	3	
4-2-08	Mapulehu	HV	2	0	3	
4-2-09	Kaluaaha		0	0	4	
4-2-10	Kahananui		0	0	4	
4-2-11	Manawai		0	0	4	
4-2-12	Ohia		0	0	4	
4-2-13	Wawaia	SU	2	0	3	
4-2-14	Kamalo	HFUV	7	5	2	
4-2-15	Kawela	CHFSUV	8	2	1	
4-2-16	Papio	V	1	1	3	
Maui						
6-1-01	Ukumehame	HFSV	4	0	3	
6-1-02	Olowalu		0	0	4	
6-1-03	Laniupoku	H	1	0	3	
6-1-04	Kauaula		0	0	4	
6-1-05	Kahoma	HV	2	2	2	
6-1-06	Wahikuli		0	0	4	
6-1-07	Honokowai	HFSV	4	3	2	
6-1-08	Kahana		0	0	4	
6-1-09	Honokahua		0	0	4	
6-1-10	Honolua		0	0	4	
6-1-11	Honokohau	H	1	1	2	
6-2-01	Poelua		0	0	4	
6-2-02	Honanana		0	0	4	
6-2-03	Kahakuloa	FS	2	0	3	
6-2-05	Waiolai		0	0	4	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
6-2-06	Makamakaole	HFS	3	1	1	
6-2-07	Waihee R.	HFSUV	5	5	1	1
6-2-08	Waiehu	S	1	0	3	
6-2-09	Iao	HFSPNV	10	6	1	1
6-2-10	Waikapu	HSNV	4	2	2	
6-3-01	Maliko	HFSN	4	1	2	
6-3-02	Kuiaha		0	0	4	
6-3-03	Kaupakulua	S	1	0	3	
6-3-04	Manawaiiao		0	0	4	
6-3-05	Uaoa		0	0	4	
6-3-07	Kakipi	HS	2	0	3	
6-3-08	Honopou	S	1	0	3	
6-3-09	Hoolawa	HSV	3	2	2	
6-3-10	Waipio		0	0	4	
6-3-11	Hanehoi		0	0	4	
6-3-12	Hoalua		0	0	4	
6-3-13	Hanawana	HS	2	0	3	
6-3-14	Kailua	S	1	1	2	
6-3-15	Nailiilihaele	SV	2	0	3	
6-4-01	Oopuola	HUV	5	2	2	
6-4-02	Kaaiea	HSV	5	0	2	
6-4-03	Kolea		0	0	4	
6-4-04	Waikamoi	SUV	5	0	2	
6-4-06	Puohokamoa	SUV	5	2	2	
6-4-07	Haipuaena	SUV	4	0	3	
6-4-08	Punalau		0	0	4	
6-4-09	Honomanu	CHFSUV	8	3	1	
6-4-10	Nuaailua	HFV	5	1	2	
6-4-11	Piinau	HFSUNV	6	5	1	
6-4-12	Ohia	FV	2	1	2	
6-4-13	Waiokamilo	FSUV	9	3	1	
6-4-14	West Wailuanui	FSUV	7	5	1	
6-4-15	West Wailuaiki	HFSUV	8	3	1	
6-4-16	East Wailuaiki	HFSUV	8	3	1	
6-4-17	Kopiliula	FSUV	5	0	2	
6-4-18	Waiohue	CHFSPV	12	9	1	
6-4-19	Paakea	F	1	1	2	
6-4-20	Waiaaka	F	1	1	2	
6-4-21	Kapaula	F	1	1	2	
6-4-22	Hanawi	CHFSUV	12	8	1	
6-4-23	Makapipi	HFSUV	6	2	2	
6-4-24	Kuhiwa	HFSUV	5	0	2	
6-4-25	Waihole	HS	2	0	3	
6-4-26	Manawaikeae	HFSV	6	0	2	
6-4-27	Kahawaihapapa	HFSV	6	0	2	
6-4-28	Keaaiki	HFSV	6	0	2	
6-4-29	Waioni	HFSV	6	0	2	
6-4-30	Lanikele	HFSV	6	0	2	
6-4-31	Heleleikeoha	HSUV	5	3	2	
6-4-32	Kawakoe	HFSV	6	5	1	
6-4-33	Ulaino	HSUNV	6	0	2	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
6-4-34	Kawaipapa	S	1	0	3	
6-4-36	Unnamed		0	0	4	
6-5-01	Moomoonui	HU	2	0	3	
6-5-02	Haneoo	HU	2	0	3	
6-5-03	Kapia	HU	2	1	2	
6-5-04	Waiohonu	SU	2	2	2	
6-5-05	Papaahawahawa	HUV	4	1	2	
6-5-06	Alaalaula	CHFSU	5	2	2	
6-5-07	Wailua	HFSUV	8	7	1	
6-5-08	Honolewa	HFSUV	8	7	1	
6-5-09	Waieli	HFSUV	8	5	1	
6-5-10	Kakiweka	FSUV	4	2	2	
6-5-11	Hahalawa	HFSUV	7	6	1	
6-5-12	Puaaluu	HFSUV	9	8	1	
6-5-13	Oheo Gulch	CHFSPUV	13	11	1	1
6-5-15	Koukouai	FSUV	7	6	1	
6-5-16	Opelu	HUV	4	3	2	
6-5-17	Kukuiula	HUV	4	3	2	
6-5-18	Kaapahu	HU	3	1	2	
6-5-19	Lelekea	HFUV	8	1	2	
6-5-20	Alelele	CHFSUV	12	12	1	
6-5-21	Kalepa	CHFUV	7	5	1	
6-5-22	Nuanuaaloa	CHFUV	6	3	2	
6-5-24	Manawainui	HSUV	5	4	1	
		Hawaii				
8-1-03	Kumakua		0	0	4	
8-1-06	Hanaula		0	0	4	
8-1-07	Hapahapai		0	0	4	
8-1-08	Pali Akamoa		0	0	4	
8-1-09	Wainaia		0	0	4	
8-1-10	Unnamed		0	0	4	
8-1-11	Halawa		0	0	4	
8-1-12	Aamakao	CS	2	2	2	
8-1-13	Niulii	CP	2	0	3	
8-1-14	Waikama	S	1	1	2	
8-1-15	Pololu	CHV	7	7	1	
8-1-16	Honokane Nui	CHFSUV	9	6	1P	1
8-1-17	Honokane Iki	CHFUV	8	6	1P	
8-1-18	Kalele Gl.	HFUV	6	4	2	
8-1-19	Waipahi	HFUV	6	4	2P	
8-1-20	Honokea	CHFUV	7	4	1P	
8-1-21	Kailikaula	HFUV	6	4	2P	
8-1-22	Honopue	CHFSUV	9	5	1P	
8-1-23	Kolealiilii	CHFUV	8	5	1P	
8-1-24	Ohiahuea	HFUV	7	5	1P	
8-1-25	Nakooko	HV	4	4	2	
8-1-26	Waiapuka	CHV	5	5	1	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
8-1-27	Waikaloa	HV	4	4	2	
8-1-28	Waimaile	HV	3	3	2	
8-1-29	Kukui	HV	3	3	2	
8-1-30	Paopao	HV	3	3	2	
8-1-31	Waiaalala	HUV	4	3	2	
8-1-32	Punalulu		0	0	4	
8-1-33	Kaimu	HV	3	3	2	
8-1-34	Pae	HV	3	3	2	
8-1-35	Waimanu	CHFSBUV	9	6	1	1
8-1-36	Pukoa	CHFS	4	1	2	
8-1-37	Manuwaikaalio	CHFS	4	1	2	
8-1-38	Naluea	CHFS	4	1	2	
8-1-39	Kahoopuu	CHFS	4	2	2	
8-1-42	Waipahoehoe	CHFS	4	2	2	
8-1-44	Wailoa/Waipio	CHFSBV	9	7	1	
8-1-45	Lalakea	HFSV	4	2	2P	1
8-1-46	Kaluahine Falls	V	1	1	2	
8-1-47	Waiulili		0	0	4	
8-1-49	Waipunahoe	U	1	0	3	
8-1-50	Waialeale	U	1	0	3	
8-1-51	Waikoloa	U	1	0	3	
8-1-52	Kapulena	U	1	0	3	
8-1-53	Kawaikalia	U	1	0	3	
8-1-54	Malanahae	U	1	0	3	
8-1-61	Nienie	U	1	0	3	
8-1-62	Papuaa	U	1	0	3	
8-1-65	Kahaupu	U	1	0	3	
8-1-66	Kahawailiili	U	1	0	3	
8-1-67	Keahua	U	1	0	3	
8-1-68	Kalopa	U	1	0	3	
8-1-69	Waikaalulu	U	1	0	3	
8-1-70	Kukuilamalamahii	U	1	0	3	
8-1-71	Alilipali	U	1	0	3	
8-1-73	Kaumoali	U	1	0	3	
8-1-76	Waipunahina	U	1	0	3	
8-1-77	Waipunalau Gl	U	1	0	3	
8-1-78	Paauilo	U	1	0	3	
8-1-79	Aamanu	U	1	0	3	
8-1-80	Koholalele Gl	U	1	0	3	
8-1-81	Kalapahapu Gl	U	1	0	3	
8-1-82	Kukaiau	U	1	0	3	
8-1-85	Kaala	U	1	0	3	
8-1-86	Kealakaha	U	1	0	3	
8-1-88	Kupapaulua	U	1	0	3	
8-1-89	Kaiwiki	U	1	0	3	
8-1-90	Kaula	U	1	0	3	
8-2-01	Kaohaoha	FUV	5	0	2	
8-2-02	Kaawalii	HFSUV	7	0	3	
8-2-03	Waipunalei	FUV	5	0	3	
8-2-04	Laupahoehoe	CFPUV	7	0	2	
8-2-05	Kilau	HFSUV	8	2	2	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
8-2-06	Manowaiopae	FSUV	6	0	2	
8-2-07	Kuwaikahi	FSUV	7	0	2	
8-2-08	Kihalani	FUV	5	0	3	
8-2-09	Kaiwilahilahi	FSUV	8	2	1	
8-2-10	Haakoa	FSUV	6	0	2	
8-2-11	Pahale	FUV	6	0	2	
8-2-12	Kapehu		0	0	4	
8-2-13	Paeohe	FSUV	6	0	2	
8-2-14	Maulua	FSUV	6	1	2	
8-2-16	Pohakupuka	FSUV	6	0	2	
8-2-17	Kulanakii		0	0	4	
8-2-18	Ahole	FUV	5	0	3	
8-2-19	Poupou	FUV	5	0	3	
8-2-20	Manoloa	FSUV	7	0	2	
8-2-21	Ninole	FSUV	7	1	2	
8-2-22	Kaaheiki	V	2	0	3	
8-2-23	Waikolu	V	2	0	3	
8-2-24	Waikaumalo	HFSPUV	9	1	2	
8-2-25	Kahuku	V	2	0	3	
8-2-26	Waiehu	FUV	5	0	3	
8-2-27	Nanue	HFSUV	8	3	1	
8-2-28	Opea	FSUV	7	1	2	
8-2-29	Peleau	FUV	6	0	2	
8-2-30	Umauma	HFSUV	7	1	2	
8-2-31	Kamaee	FSUV	6	0	2	
8-2-32	Hakalau	CFSUV	8	3	1	
8-2-33	Kolekole	CHFSPUV	13	7	1	1
8-2-34	Paheehee	FUV	5	0	3	
8-2-35	Honomu	V	2	0	3	
8-2-36	Laimi	HFUV	7	0	2	
8-2-37	Kapehu	FSUV	6	0	2	
8-2-38	Makea	V	2	0	3	
8-2-39	Alia	V	2	0	3	
8-2-40	Makahanaloa	V	2	0	3	
8-2-41	Waimaauou	V	2	0	3	
8-2-42	Waiaama	FSUV	6	0	2	
8-2-43	Kawainui	HFSBUV	10	3	1	
8-2-44	Onomea	HFSPUV	9	2	2	
8-2-45	Alakahi	HFSPUV	9	1	2	
8-2-46	Hanawi	HFSUNV	10	1	2	
8-2-47	Kalaoa	FUV	6	1	2	
8-2-48	Aleamai	V	2	0	3	
8-2-49	Kaieie	FSUV	6	0	2	
8-2-50	Puuokalepa	V	2	0	3	
8-2-51	Kaapoko	V	2	0	3	
8-2-52	Papaikou	V	2	0	3	
8-2-53	Kapue	FSUV	6	0	2	
8-2-54	Pahoehoe	FSUV	7	0	2	
8-2-55	Paukaa	V	2	0	3	
8-2-56	Honolii	HFSBPUV	10	2	1	
8-2-57	Maili	FSUV	6	0	2	

CODE	STREAM	OPPORTUNITIES	EXP	PLUS	REG	STATE
8-2-59	Pukihae	FSUV	6	0	2	
8-2-60	Wailuku R.	HFSPUV	13	6	1	1
8-2-61	Wailoa R.	HFBPV	6	3	2	
8-2-62	Kaahakina		0	0	4	
8-4-02	Waiaha		0	0	4	
8-5-01	Haloa		0	0	4	
8-5-02	Lamimaumau		0	0	4	
8-5-03	Waikoloa		0	0	4	

Table 39 Recreational Resource Datasheet

Island = Code = Stream Name =

	Urban + ✓ ?	Country + ✓ ?	Semi-Nat + ✓ ?	Natural + ✓ ?	Explain all +'s
Camp	O O O	O O O	O O O	O O O	Camp
Hike	O O O	O O O	O O O	O O O	Hike
Fish	O O O	O O O	O O O	O O O	Fish
Hunt			O O O	O O O	Hunt
Swim	O O O	O O O	O O O	O O O	Swim
Boat	O O O	O O O	O O O	O O O	Boat
Parks	O O O	O O O	O O O	O O O	Parks
Park Names	______ ______	______ ______	______ ______	______ ______	
	Educational + ✓ ?	Botanical Gardens + ✓ ?			
Nature Study	O O O	O O O			Nature Study
Names	______	______			
	Trail + ✓ ?	Road + ✓ ?	Air + ✓ ?	Ocean + ✓ ?	
Scenic Views	O O O	O O O	O O O	O O O	Scenic Views

Access Problems — Note Activity, ROS Category and Comments

Access Forbidden
Access with Waiver
Other______________

Detractions — Note Activity, ROS Category and Comments

Overuse
Polluted
Inadequate Facilities
Litter
Discarded tires, appliances, cars etc.
Noise from Heliocopters
Altered Flow/diversion/channeled
Other______________

Local Importance Describe:

Potential Describe what might make this stream outstanding:

Unique Features Describe feature that makes stream outstanding:

Map 7

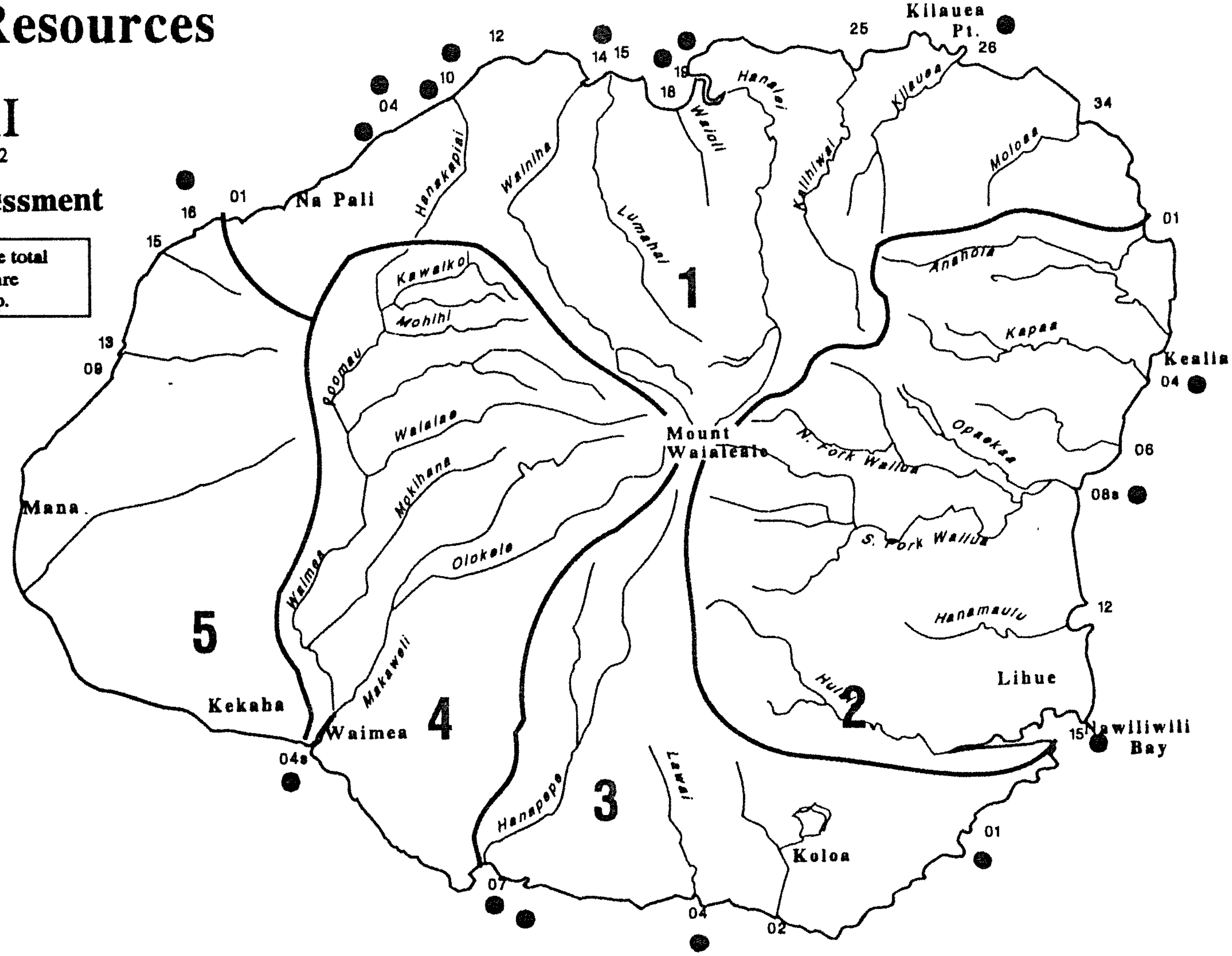
Regionally Outstanding Recreational Resources

KAUAI

Island Code - 2

Hawaii Stream Assessment

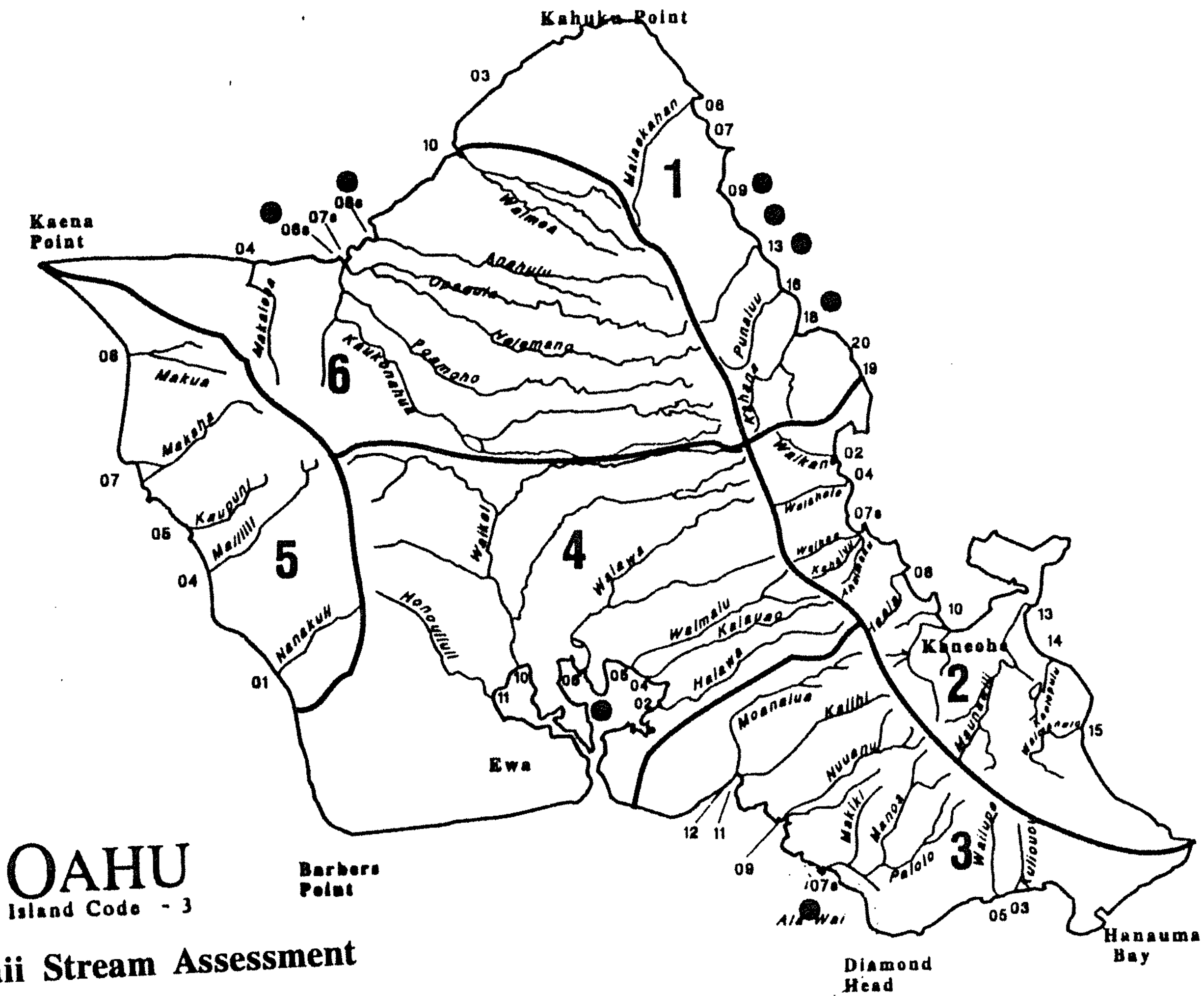
Note:	Only a portion of the total number of streams are depicted on this map.



2-1-03	Nakeikionaiwi
2-1-04	Kalalau
2-1-07	Hanakoa
2-1-10	Hanakapiai
2-1-14	Wainiha R.
2-1-18	Waioli
2-1-19	Hanalei R.
2-1-28	Kilauea
2-2-04	Kapaa
2-2-08s	Wailua R. System
2-2-15	Huleia
2-3-01	Kipu Kai
2-3-04	Lawai
2-3-06	Wahiawa
2-3-07	Hanapepe
2-4-04s	Waimea S
2-5-16	Nualolo

Map 7

Regionally Outstanding Recreational Resources



3-1-09	Koloa Gl.
3-1-11	Maakua
3-1-13	Kaluanui
3-1-18	Kahana
3-3-07s	Ala Wai C. System
3-6-06s	Kiikii System
3-6-08s	Anahulu System

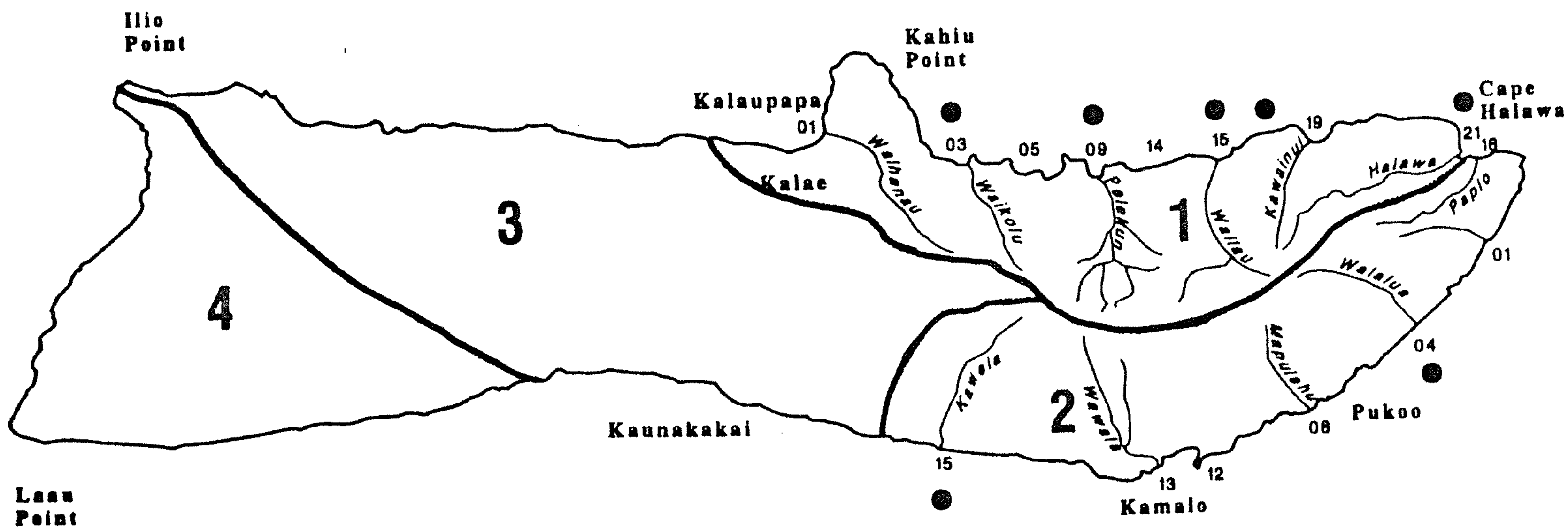
OAHU
Island Code - 3

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Map 7

Regionally Outstanding Recreational Resources



4-1-03	Waikolu
4-1-09	Pelekunu
4-1-15	Wailau
4-1-17	Waiahookalo
4-1-21	Halawa
4-2-04	Waialua
4-2-15	Kawela

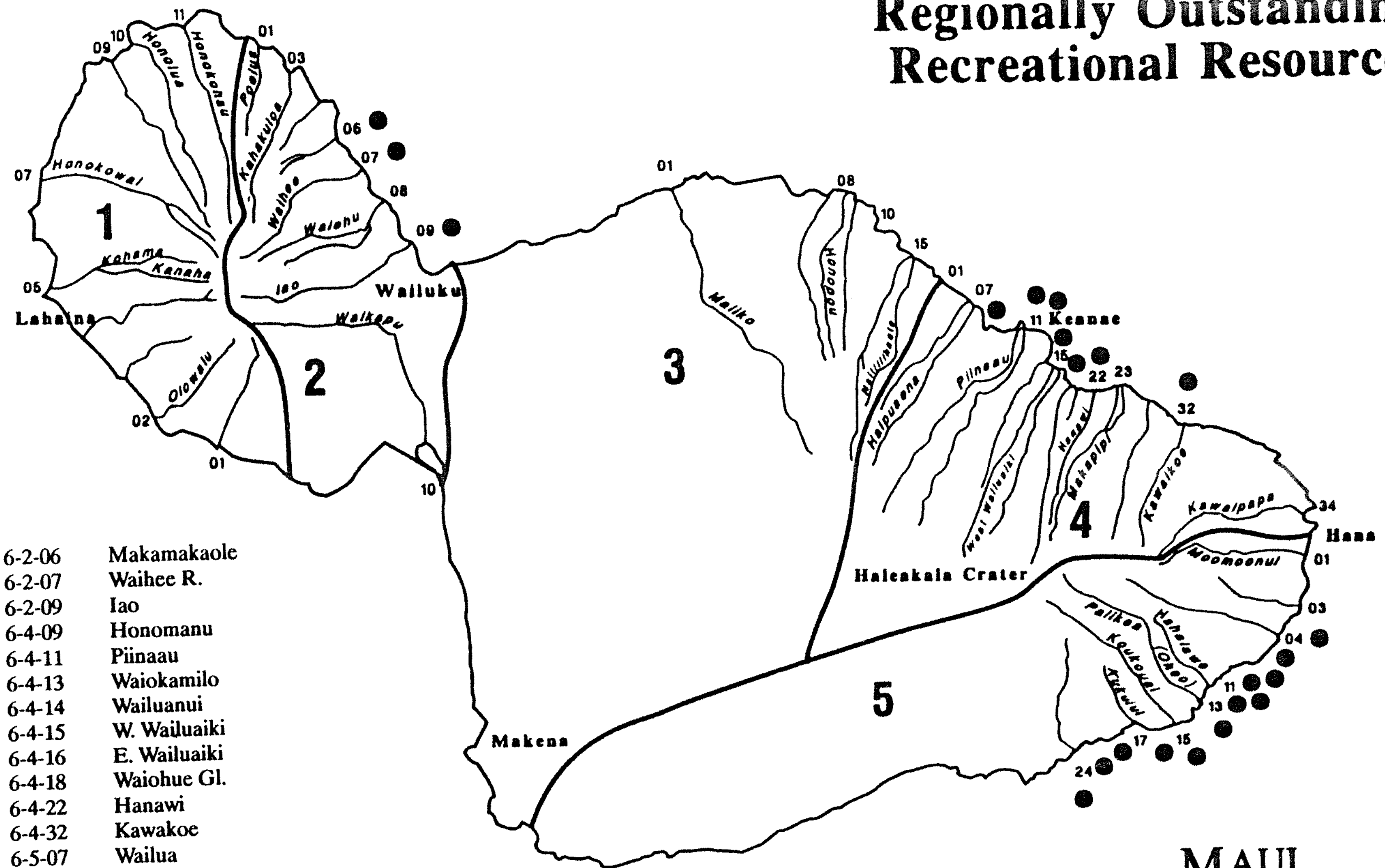
MOLOKAI
Island Code - 4

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Map 7

Regionally Outstanding Recreational Resources



6-2-06	Makamakaole
6-2-07	Waihee R.
6-2-09	Iao
6-4-09	Honomanu
6-4-11	Piinaau
6-4-13	Waiokamilo
6-4-14	Wailuanui
6-4-15	W. Wailuaiki
6-4-16	E. Wailuaiki
6-4-18	Waiohue Gl.
6-4-22	Hanawi
6-4-32	Kawakoe
6-5-07	Wailua
6-5-08	Honolewa
6-5-09	Waieli
6-5-11	Hahalawe
6-5-12	Puaaluu
6-5-13	Oheo
6-5-15	Koukouai
6-5-20	Alelele
6-5-21	Kalepa
6-5-24	Manawainui

MAUI

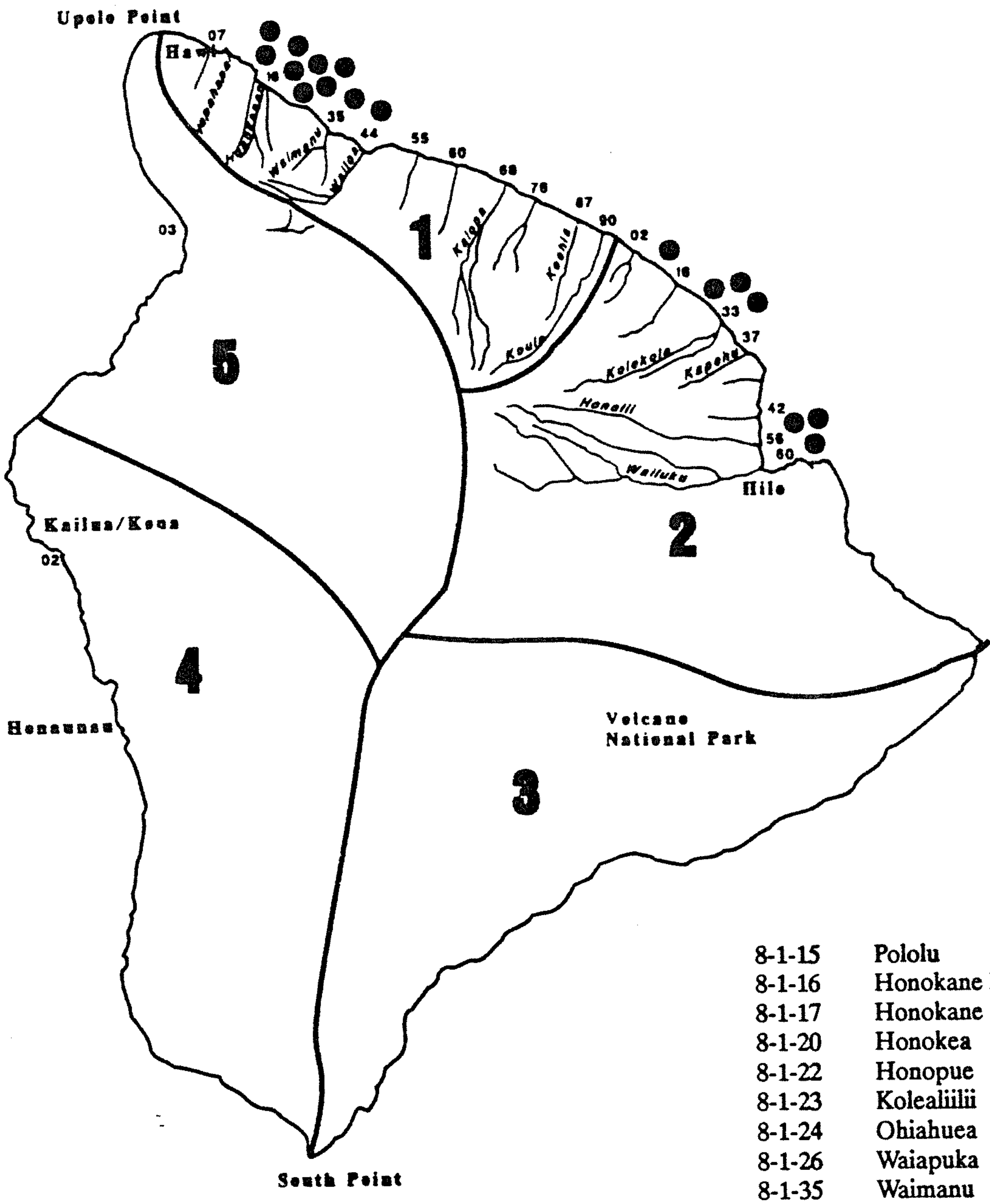
Island Code - 6

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Map 7

Regionally Outstanding Recreational Resources



8-1-15	Pololu
8-1-16	Honokane Nui
8-1-17	Honokane Iki
8-1-20	Honokea
8-1-22	Honopue
8-1-23	Kolealiilii
8-1-24	Ohiahuea
8-1-26	Waiapuka
8-1-35	Waimanu
8-1-44	Wailoa/Waipio
8-2-09	Kaiwilahilahi
8-2-27	Nanue
8-2-32	Hakalau
8-2-33	Kolekole
8-2-43	Kawainui
8-2-56	Honolii
8-2-60	Wailuku R.

HAWAII
Island Code - 8

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Table 40 Resource Assessment Summary

CODE	HSA Code; island-hydrographic unit-stream (system)	**Resource Ranks**	Aquatic, Riparian, Cultural, Recreational resource ranks. Streams with unknown resources are not ranked.
STREAM	Stream name at mouth	O	Outstanding
		S	Substantial
		M	Moderate
		L	Limited

CODE	NAME	AQU	RIP	CUL	REC
Kauai					
2-1-01	Awaawapuhi	O		O	S
2-1-02	Honopu			O	S
2-1-03	Nakeikionaiwi			O	O
2-1-04	Kalalau	O	S	O	O
2-1-05	Pohakuao	O		O	S
2-1-06	Waiolaa			O	S
2-1-07	Hanakoa	O		O	O
2-1-08	Waiahuakua	O		O	S
2-1-09	Hoolulu	L	S	O	S
2-1-10	Hanakapiai	O	S	O	O
2-1-11	Maunapuluo	O		O	M
2-1-12	Limahuli	O	S	O	S
2-1-13	Manoa	S		O	S
2-1-14	Wainiha R.	O	S	O	O
2-1-15	Lumahai R.	O	O	O	S
2-1-16	Waikoko	L			M
2-1-17	Waipa	S	O	O	
2-1-18	Waioli	S	S		O
2-1-19	Hanalei R.	O	O	O	O
2-1-20	Waileia	M	S	S	
2-1-21	Anini	M			
2-1-25	Kalihiwai R.	O	S	S	S
2-1-26	Puukumu	M			S
2-1-27	Unnamed				
2-1-28	Kilauea	M	S		O
2-1-29	Kulihaili	S		L	
2-1-30	E. Waiakalua	S		O	S
2-1-31	Pilaa	L		S	S
2-1-32	W. Waipake	L		S	S
2-1-33	E. Waipake	S			S
2-1-34	Moloaa	L			M
2-1-35	Papaa			O	
2-1-36	Aliomanu				
2-2-01	Anahola	O	S	S	S
2-2-02	Kumukumu	L			
2-2-04	Kapaa	O	S	S	O
2-2-05	Moikeha Canal				M
2-2-06	Waikaea Canal		S	S	S
2-2-08s	Wailua S.	M	O	O	O
2-2-10	Kawailoa				M
2-2-12	Hanamaulu	L	S	L	S
2-2-13	Nawiliwili			L	M
2-2-14	Puali			L	M
2-2-15	Huleia	O	O	L	O
2-3-01	Kipu Kai		S	L	S
2-3-02	Waikomo	M	S	O	M
2-3-04	Lawai	M		O	S
2-3-06	Wahiawa		S	O	O
2-3-07	Hanapepe	M	O	O	O
2-4-01	Mahinauli				M
2-4-02	Aakukui				M
2-4-03	Waipao				M
2-4-04s	Waimea S.	M	O	O	O
2-5-06	Kinekine Ditch				
2-5-07	Kaawaloa				
2-5-08	Nahomalu		S	O	M
2-5-09	Kaulaula			O	M
2-5-10	Haeleele			O	M
2-5-13	Kauhao			O	M
2-5-15	Milolii	O	S	O	S
2-5-16	Nualolo	O	O	O	O
Oahu					
3-1-03	Paumalu			S	S
3-1-04	Kawela				
3-1-05	Oio			S	M
3-1-06	Malaekahana				M
3-1-07	Kahawainui	L		S	S
3-1-08	Wailele Gl.				

CODE	NAME	AQU	RIP	CUL	REC
3-1-09	Koloa Gl.	O	S		O
3-1-10	Kaipapau	L		S	S
3-1-11	Maakua	L		S	O
3-1-13	Kaluanui	O	S	S	O
3-1-16	Punaluu	O	S	S	S
3-1-18	Kahana	O	O	O	O
3-1-19	Kaaawa	O			S
3-1-20	Makaua	O			M
3-1-21	Unnamed				
3-2-01	Hakipuu	M		S	
3-2-02	Waikane	M		S	S
3-2-03	unnamed			S	M
3-2-04	Waiahole	M	S	S	S
3-2-05	Kaalaea	M			M
3-2-07s	Kahaluu S.	M		S	S
3-2-08	Heeia	M	O		S
3-2-09	Keaahala	M			M
3-2-10	Kaneohe	M	S		S
3-2-11	Kawa				M
3-2-13	Kawainui/ Maunawili	L	O	O	S
3-2-14	Kaelepulu Canal	L	S		S
3-2-15	Waimanalo	M	S	O	S
3-3-03	Kuliouou				S
3-3-04	Niu				S
3-3-05	Wailupe				S
3-3-06	Waialaenui				S
3-3-07s	Ala Wai S.	M			O
3-3-09	Nuuanu	L	S		S
3-3-10	Kapalama				M
3-3-11	Kalihi	M			M
3-3-12	Moanalua			O	S
3-4-02	Halawa	L		O	S
3-4-03	Aiea				M
3-4-04	Kalauao				S
3-4-05	Waimalu				S
3-4-06	Waiawa	M			S
3-4-10	Waikele	L	O	L	M
3-4-11	Honouliuli		S	L	M
3-5-01	Nanakuli			S	S
3-5-02	Ulehawa				S
3-5-04	Mailiili				S
3-5-05	Kaupuni			O	S
3-5-07	Makaha	M		S	S
3-5-08	Makua				M
3-6-03	Unnamed				

CODE	NAME	AQU	RIP	CUL	REC
3-6-04	Makaleha		O		M
3-6-06s	Kiikii S.	M	S		O
3-6-07s	Paukauila S.	O	S		S
3-6-08s	Anahulu S.	S	S		O
3-6-09	Loko Ea	L	S		M
3-6-10	Waimea R.	M	O	S	S

Molokai

CODE	NAME	AQU	RIP	CUL	REC
4-1-01	Waihanau		S	O	S
4-1-02	Waialeia			S	S
4-1-03	Waikolu	O	S	S	O
4-1-04	Wainene		O		M
4-1-05	Anapuhi		S	S	S
4-1-06	Waiohookalo	O	S		
4-1-07	Keawanui				M
4-1-08	Kailiili			O	M
4-1-09	Pelekunu	O	O	O	O
4-1-10	Waipu		S		M
4-1-11	Haloku				S
4-1-12	Oloupena		S		S
4-1-13	Puukaoku		S		S
4-1-14	Wailele		S		S
4-1-15	Wailau	O		O	O
4-1-17	Waiahookalo				O
4-1-18	Kahiwa				S
4-1-19	Kawainui				S
4-1-20	Pipiwai				
4-1-21	Halawa	O		O	O
4-1-22	Hakaaano				M
4-2-01	Pohakupili			S	
4-2-02	Honoulimaloo			O	M
4-2-03	Honouliwai			O	S
4-2-04	Waialua			O	O
4-2-05	Kainalu			O	M
4-2-06	Honomuni		S	S	M
4-2-08	Mapulehu			O	M
4-2-09	Kaluaaha			O	
4-2-10	Kahananui			S	
4-2-11	Manawai			O	
4-2-12	Ohia			S	
4-2-13	Wawaia			S	M
4-2-14	Kamalo	L	S	O	S
4-2-15	Kawela	L	S	O	O
4-2-16	Papio				M

CODE	NAME	AQU	RIP	CUL	REC
Maui					
6-1-01	Ukumehame	S		S	M
6-1-02	Olowalu	S		S	
6-1-03	Launiupoku				M
6-1-04	Kauaula	L			
6-1-05	Kahoma	M	O	S	S
6-1-06	Wahikuli				
6-1-07	Honokowai	L	O	S	S
6-1-08	Kahana				
6-1-09	Honokahua			S	
6-1-10	Honolua	L		O	
6-1-11	Honokohau	O	S	O	S
6-2-01	Poelua				
6-2-02	Honanana			L	
6-2-03	Kahakuloa	O	S	O	M
6-2-05	Waiolai			S	
6-2-06	Makamakaole	O		S	O
6-2-07	Waihee R.	O		O	O
6-2-08	Waiehu	S		S	M
6-2-09	Iao	S	S		O
6-2-10	Waikapu	S	O	S	S
6-3-01	Maliko			S	S
6-3-02	Kuiaha				
6-3-03	Kaupakulua			S	M
6-3-04	Manawaiiao				
6-3-05	Uaoa				
6-3-07	Kakipi			S	M
6-3-08	Honopou			S	M
6-3-09	Hoolawa	L		S	S
6-3-10	Waipio				
6-3-11	Hanehoi				
6-3-12	Hoalua			S	
6-3-13	Hanawana			S	M
6-3-14	Kailua	M		S	S
6-3-15	Nailiilihaele	L			M
6-4-01	Oopuola				S
6-4-02	Kaaiea				S
6-4-03	Kolea				
6-4-04	Waikamoi	L	S		S
6-4-06	Puohokamoa	L	S		S
6-4-07	Haipuaena	L			M
6-4-08	Punalau	L			
6-4-09	Honomanu	L	O		O
6-4-10	Nuaailua	L			S
6-4-11	Piinaau	O	O		O
6-4-12	Ohia			S	S

CODE	NAME	AQU	RIP	CUL	REC
6-4-13	Waiokamilo				O
6-4-14	Wailuanui	O	S	S	O
6-4-15	W. Wailuaiki	M	S		O
6-4-16	E. Wailuaiki	M	O		O
6-4-17	Kopiliula	M	O		S
6-4-18	Waiohue Gl.	O			O
6-4-19	Paakea	M			S
6-4-20	Waiaaka				S
6-4-21	Kapaula	L			S
6-4-22	Hanawi	O	O		O
6-4-23	Makapipi	O		O	S
6-4-24	Kuhiwa		S		S
6-4-25	Waihole				M
6-4-26	Manawaikeae				S
6-4-27	Kahawaihapapa				S
6-4-28	Keaaiki				S
6-4-29	Waioni				S
6-4-30	Lanikele				S
6-4-31	Heleleikeoha		S		S
6-4-32	Kawakoe				O
6-4-33	Ulaino	O		S	S
6-4-34	Kawaipapa			S	M
6-4-36	Unnamed				
6-5-01	Moomoonui			S	M
6-5-02	Haneoo			S	M
6-5-03	Kapia	O			S
6-5-04	Waiohonu		S	S	S
6-5-05	Papaahawa-hawa			S	S
6-5-06	Alaalaula			S	S
6-5-07	Wailua	O			O
6-5-08	Honolewa	O			O
6-5-09	Waieli	O			O
6-5-10	Kakiweka	O			S
6-5-11	Hahalawe	O			O
6-5-12	Puaaluu	O		S	O
6-5-13	Oheo Gl.	O	O	S	O
6-5-15	Koukouai			O	O
6-5-16	Opelu				S
6-5-17	Kukuiula	O			S
6-5-18	Kaapahu				S
6-5-19	Lelekea			O	S
6-5-20	Alelele	O		S	O
6-5-21	Kalepa			S	O
6-5-22	Nuanuaaloa				S
6-5-24	Manawainui	O		O	O

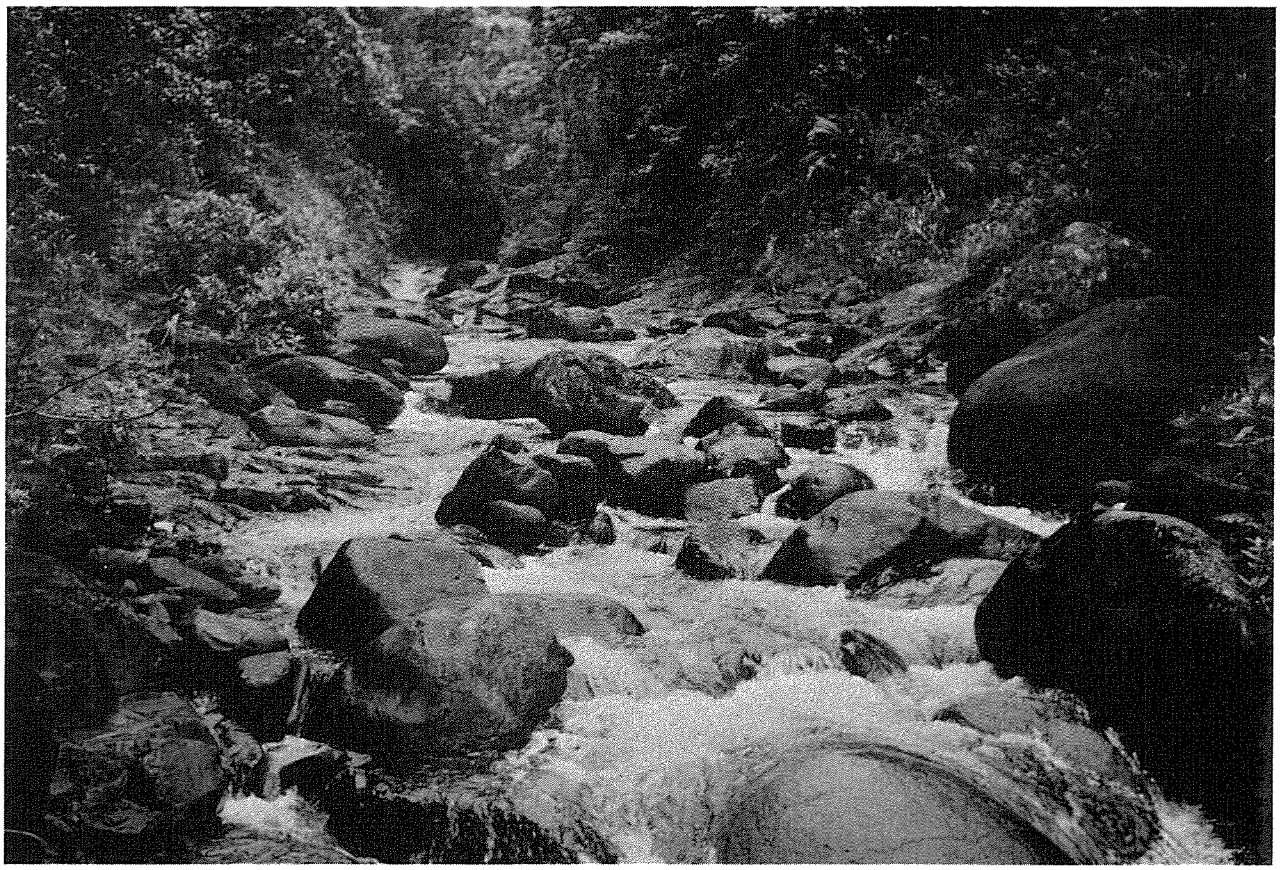
CODE	NAME	AQU	RIP	CUL	REC
Hawaii					
8-1-03	Kumakua				
8-1-06	Hanaula				
8-1-07	Hapahapai				
8-1-08	Pali Akamoa				
8-1-09	Wainaia				
8-1-10	Unnamed				
8-1-11	Halawa			O	
8-1-12	Aamakao	O		O	S
8-1-13	Niulii			O	M
8-1-14	Waikama			O	S
8-1-15	Pololu		O	O	O
8-1-16	Honokane Nui	M	S	O	O
8-1-17	Honokane Iki			O	O
8-1-18	Kalele Gl.				S
8-1-19	Waipahi			O	S
8-1-20	Honokea				O
8-1-21	Kailikaula				S
8-1-22	Honopue			O	O
8-1-23	Kolealiilii				O
8-1-24	Ohiahuea		S		O
8-1-25	Nakooko			O	S
8-1-26	Waiapuka				O
8-1-27	Waikaloa				S
8-1-28	Waimaile				S
8-1-29	Kukui				S
8-1-30	Paopao				S
8-1-31	Waiaalala			O	S
8-1-32	Punalulu			O	
8-1-33	Kaimu		S	O	S
8-1-34	Pae		S	O	S
8-1-35	Waimanu	M	O	O	O
8-1-36	Pukoa				S
8-1-37	Manuwaikaalio				S
8-1-38	Naluea	L			S
8-1-39	Kahoopuu				S
8-1-42	Waipahoehoe	L			S
8-1-44	Wailoa/Waipio	O	O	O	O
8-1-45	Lalakea	O	S		S
8-1-46	Kaluahine Falls			O	S
8-1-47	Waiulili			O	
8-1-49	Waipunahoe			O	M
8-1-50	Waialeale			O	M
8-1-51	Waikoloa	L		O	M
8-1-52	Kapulena			O	M
8-1-53	Kawaikalia			O	M
8-1-54	Malanahae			O	M

CODE	NAME	AQU	RIP	CUL	REC
8-1-61	Nienie				M
8-1-62	Papuaa				M
8-1-65	Kahaupu				M
8-1-66	Kahawailiili				M
8-1-67	Keahua				M
8-1-68	Kalopa				M
8-1-69	Waikaalulu				M
8-1-70	Kukuilama-lamahii				M
8-1-71	Alilipali				M
8-1-73	Kaumoali Gl.				M
8-1-76	Waipunahina				M
8-1-77	Waipunalau Gl.				M
8-1-78	Paauilo				M
8-1-79	Aamanu				M
8-1-80	Koholalele Gl.				M
8-1-81	Kalapahapu Gl.				M
8-1-82	Kukaiau				M
8-1-85	Kaala				M
8-1-86	Kealakaha				M
8-1-88	Kupapaulua				M
8-1-89	Kaiwiki				M
8-1-90	Kaula				M
8-2-01	Kaohaoha				S
8-2-02	Kaawalii	O	S		M
8-2-03	Waipunalei				M
8-2-04	Laupahoehoe			S	S
8-2-05	Kilau	O			S
8-2-06	Manowaiopae	O			S
8-2-07	Kuwaikahi	O			S
8-2-08	Kihalani				M
8-2-09	Kaiwilahilahi	O	S		O
8-2-10	Haakoa				S
8-2-11	Pahale				S
8-2-12	Kapehu	O			
8-2-13	Paeohe				S
8-2-14	Maulua	O			S
8-2-16	Pohakupuka	O			S
8-2-17	Kulanakii				
8-2-18	Ahole				M
8-2-19	Poupou				M
8-2-20	Manoloa	O			S
8-2-21	Ninole	O			S
8-2-22	Kaaheiki				M
8-2-23	Waikolu				M
8-2-24	Waikaumalo	L	S		S
8-2-25	Kahuku				M
8-2-26	Waiehu				M

CODE	NAME	AQU	RIP	CUL	REC
8-2-27	Nanue	O			O
8-2-28	Opea	O			S
8-2-29	Peleau	O			S
8-2-30	Umauma	S	S		S
8-2-31	Kamaee				S
8-2-32	Hakalau	O	S		O
8-2-33	Kolekole	O	S		O
8-2-34	Paheehee	O			M
8-2-35	Honomu	O			M
8-2-36	Laimi				S
8-2-37	Kapehu	O			S
8-2-38	Makea				M
8-2-39	Alia				M
8-2-40	Makahanaloa				M
8-2-41	Waimaauou				M
8-2-42	Waiaama	L			S
8-2-43	Kawainui	M	S		O
8-2-44	Onomea				S
8-2-45	Alakahi	S			S
8-2-46	Hanawi	O			S

CODE	NAME	AQU	RIP	CUL	REC
8-2-47	Kalaoa				S
8-2-48	Aleamai				M
8-2-49	Kaieie	L			S
8-2-50	Puuokalepa				M
8-2-51	Kaapoko	O			M
8-2-52	Papaikou				M
8-2-53	Kapue	M	S		S
8-2-54	Pahoehoe	S			S
8-2-55	Paukaa				M
8-2-56	Honolii	O	O	L	O
8-2-57	Maili	O			S
8-2-59	Pukihae	S			S
8-2-60	Wailuku R.	M	O		O
8-2-61	Wailoa R.	S		O	S
8-2-62	Kaahakini				
8-4-02	Waiaha				
8-5-01	Haloa				
8-5-02	Lamimaumau				
8-5-03	Waikoloa	L		O	

Candidate Streams for Protection



Candidate Streams for Protection

Identification of streams eligible for preservation and protection is the primary mandate of the Hawaii Stream Assessment. There are various ways or combinations of ways to approach the selection of streams for a protection program. The six included here were developed by the study team and others and revised based on public comment.

Approach 1: All Streams with Outstanding Resources

The broadest approach to the selection of candidate streams for protection is to include all those ranked Outstanding in any resource area. This would result in almost half of Hawaii's streams being so identified. The results of this approach are listed in Table 40 Resource Assessment Summary.

Approach 2: Streams with Diverse or Blue Ribbon Resources

A more discriminating approach to the identification of streams for protection is to include streams that meet one of two criteria:

- Diversity of resources
- Blue Ribbon resources

Diversity of Resources

Presence of a diversity of resources as identified by the four resource assessments---Aquatic, Riparian, Cultural, Recreational---should be considered candidates for protection. Those streams which were ranked Outstanding (or, in the case of Recreation, regionally Outstanding) in at least three resource areas are considered high in diversity of resources (Table 40).

Blue Ribbon Resources

Blue ribbon resources stand out among the best in the resource area. The four resource committees generally defined Outstanding broadly, which resulted in a large number of streams ranked Outstanding. The study team further discriminated among these Outstanding streams by using the committee criteria in a more selective way. Although committee information was used, these blue ribbon criteria were not developed by the committee members.

Aquatic blue ribbon resources: The Aquatic Resource Committee considered a stream that met any one of five criteria outstanding: *Lentipes* at least common; spawning by selected native fish (NG1) observed; abundant populations of any one of the four NG1 aquatic species observed; all four NG1 species present; and good native species diversity and habitat. A stream which fulfills any three of these criteria was considered blue ribbon.

Riparian blue ribbon resources: Criteria used by the Riparian Resource Committee included threatened and endangered birds, waterbird recovery habitat, rare plants and communities, protected areas, wetlands and native forest. These resources were rated using a point system. Outstanding streams were those that received 6 or more points. A score of 7 or more was required for riparian blue ribbon stream status.

Cultural blue ribbon resources: Standards used for cultural blue ribbon streams are: very high archaeological sensitivity; over 50 acres of taro; or a combination of predictably high density and sensitivity, many known archaeological sites, taro and historic sites.

Recreational blue ribbon resources: The recreational assessment included camping, fishing, boating, nature study areas, parks, hiking, swimming, and scenic views. The Recreational Resources committee selected those 18 streams which it considered to be of statewide importance based on evaluation by regional committees on each island.

The results of the diversity and blue ribbon approach are shown in Table 1.

Approach 3: Streams with High Quality Natural Resources

Another approach to identifying candidate streams for protection is to consider only natural values, aquatic and riparian resources. Outstanding values in these two resource areas suggest that a stream may be relatively pristine. Eighteen streams meeting these "Kapu" criteria can be identified from Table 1. Since the HSA is based on existing information, exceptional streams with little documentation will be missed by this approach. For example, with further studies, Wailau, on Molokai, and Kahakuloa, on Maui, are likely to qualify as Kapu Streams.

Proposed criteria are:

- Outstanding for Riparian and Aquatic resources

OR

- Blue ribbon Aquatic Resources

Approach 4: Aquatic Resource Districts

There is some evidence that clusters of streams are biologically very important, and may provide values and habitats that single isolated streams do not. Protection of areas which have a high concentration of outstanding streams will provide a larger natural landscape; No attempt has been made to identify such districts.

Approach 5: Free Flowing Streams

Another approach to the identification of outstanding streams is to start with an inventory of free flowing (free of dams, diversions, or channelization) or stream segments (not identified)and protect those with the most outstanding values using any of the above approaches.

Approach 6: National Wild and Scenic Rivers

To be eligible for designation under the federal Wild and Scenic Rivers Act a stream must meet strict standards. Once designated, the streams are afforded substantial protection from federal actions that is not possible through state action alone. Hawaii's streams might be reviewed for eligibility and possible nomination.

Table 1 Candidate Streams for Protection

(Approach 2 Results: Streams that met either the diversity or blue ribbon criteria)

Code HSA Stream Code Island-Hydrographic Unit-Stream
Stream Stream Name

Diversity of resources: To meet diversity criteria a stream must be outstanding in 3 or more resource areas

- Aq Aquatic
- Cu Cultural
- Rc Recreation
- Rp Riparian

Blue Ribbon Resources: The few very best resources

- Aq Aquatic: Met 3 out of 5 criteria for outstanding
- Cu Cultural: Very high sensitivity, high density, predictability and sensitivity, or over 50 acres of taro cultivation.
- Rc Recreation: Statewide outstanding streams
- Rp Riparian: Met score of 7.

CODE	STREAM	DIVERSITY	BLUE RIBBON
	Kauai		
2-1-04	Kalalau	AqCuRc	AqCu
2-1-07	Hanakoa	AqCuRc	
2-1-10	Hanakapiai	AqCuRc	AqCuRc
2-1-11	Maunapuloa	AqCu	AqCu
2-1-14	Wainiha	AqCuRc	Aq
2-1-15	Lumahai	AqRpCu	AqRp
2-1-18	Waioli	Rc	Rc
2-1-19	Hanalei	AqRpCuRc	AqRpCuRc
2-2-08s	Wailua S.	RpCuRc	RpCuRc
2-2-15	Huleia	AqRpRc	Rp
2-3-07	Hanapepe	RpCuRc	
2-4-04s	Waimea S.	RpCuRc	RpRc
2-5-16	Nualolo	AqRpCuRc	Rp
	Oahu		
3-1-18	Kahana	AqRpCuRc	CuRc
3-2-13	Maunawili	RpCuRc	Cu
3-4-02	Halawa	Cu	Cu
3-5-05	Kaupuni		Cu
3-6-04	Makaleha		Rp
3-6-06s	Kiikii S.		Rc
	Molokai		
4-1-01	Waihanau	Cu	Cu
4-1-03	Waikolu	AqRc	Aq
4-1-09	Pelekunu	AqRpCuRc	AqCu
4-1-15	Wailau	AqCuRc	CuRc
4-1-21	Halawa	AqCuRc	AqCuRc
4-2-04	Waialua	CuRc	Rc
	Maui		
6-2-07	Waihee	AqCuRc	CuRc
6-2-08	Waiehu		Cu
6-2-09	Iao	Rc	Rc
6-2-10	Waikapu		Rp
6-4-11	Piinaau	AqRpRc	AqCu
6-4-18	Waiohue Gl.	RcAq	Aq
6-4-22	Hanawi	AqRpRc	AqRp
6-5-13	Oheo Gl.	AqRpRc	AqRc
6-5-24	Manawainui	AqCuRc	
	Hawaii		
8-1-11	Halawa	Cu	Cu
8-1-15	Pololu	RpCuRc	RpCu
8-1-16	Honokane Nui	CuRc	Rc
8-1-35	Waimanu	RpCuRc	RpCuRc
8-1-44	Wailoa/Waipio	AqRpCuRc	RpCu
8-1-45	Lalakea	AqCu	CuRc
8-2-33	Kolekole	AqRc	Rc
8-2-56	Honolii	AqRpRc	Aq
8-2-60	Wailuku	RpRc	Rc
8-5-03	Waikoloa	Cu	Cu

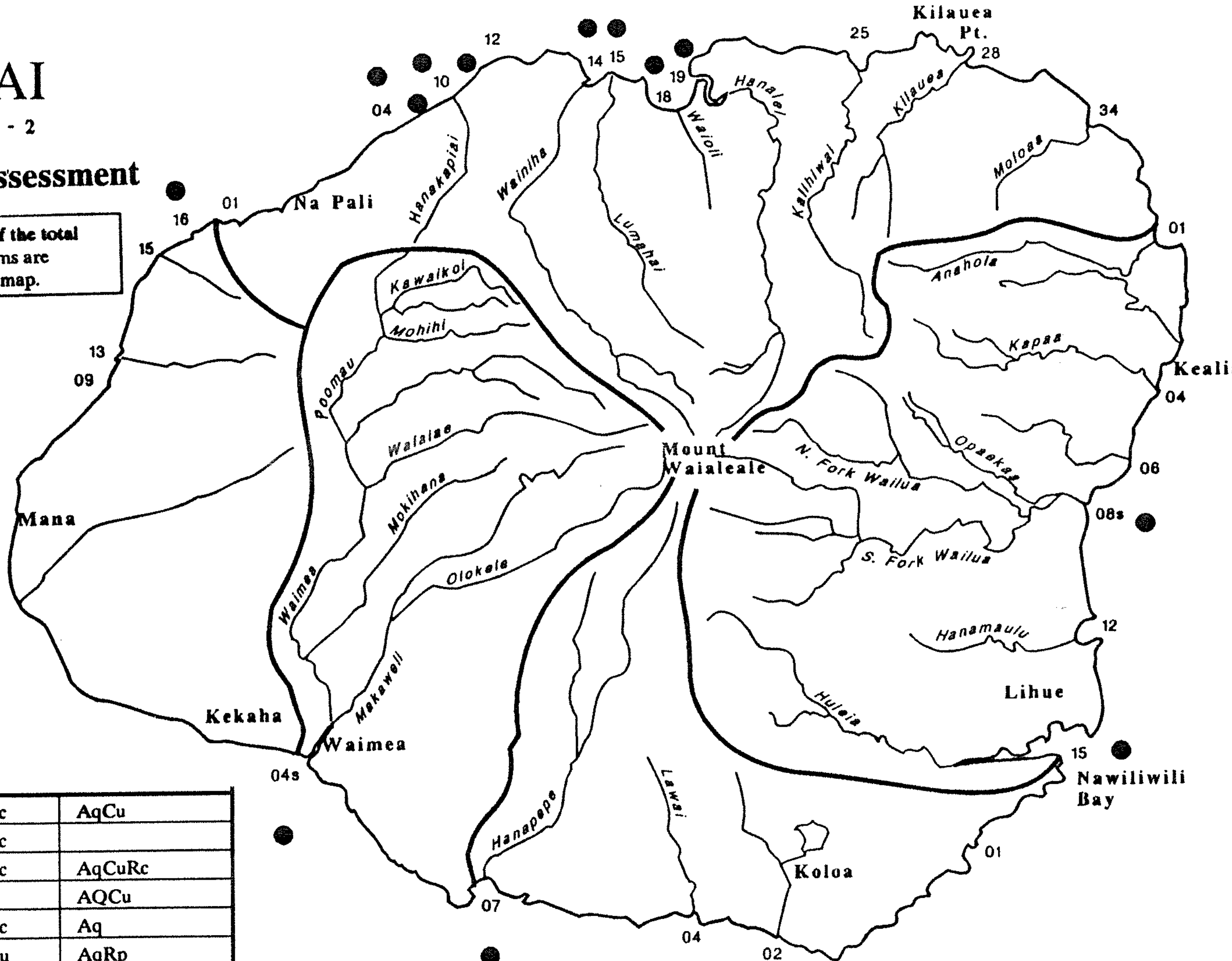
Map 8 Candidate Streams for Protection

KAUAI

Island Code - 2

Hawaii Stream Assessment

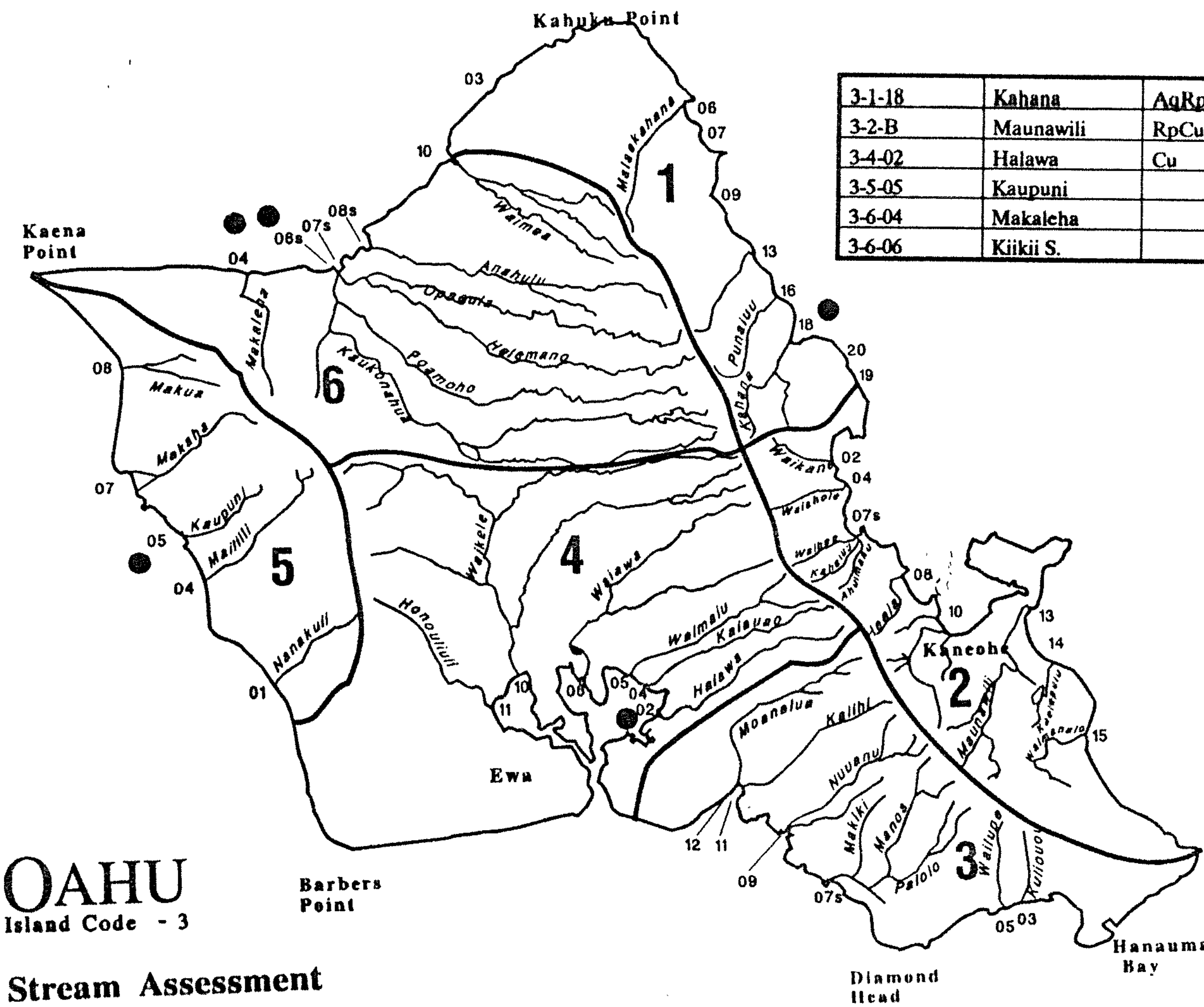
Note:	Only a portion of the total number of streams are depicted on this map.



2-1-04	Kalalau	AqCuRc	AqCu
2-1-07	Hanakoa	AqCuRc	
2-1-10	Hanakapiai	AqCuRc	AqCuRc
2-1-11	Maunapuloa	AqCu	AQCu
2-1-14	Wainiha	AqCuRc	Aq
2-1-15	Lumahai	AqRpCu	AqRp
2-1-18	Waioli	Rc	Rc
2-1-19	Hanalei	AqRpCuRc	AqRpCuRc
2-2-08s	Wailua S.	RpCuRc	RpCuRc
2-2-15	Huleia	AqRpRc	Rp
2-3-07	Hanapepe	RpCuRc	
2-4-04s	Waimea S.	RpCuRc	RpRc
2-5-16	Nualolo	AqRpCuRc	Rp

Map 8 Candidate Streams for Protection

3-1-18	Kahana	AgRpCuRc	CuRc
3-2-B	Maunawili	RpCuRc	Cu
3-4-02	Halawa	Cu	Cu
3-5-05	Kaupuni		Cu
3-6-04	Makaleha		Rp
3-6-06	Kiikii S.		Rc

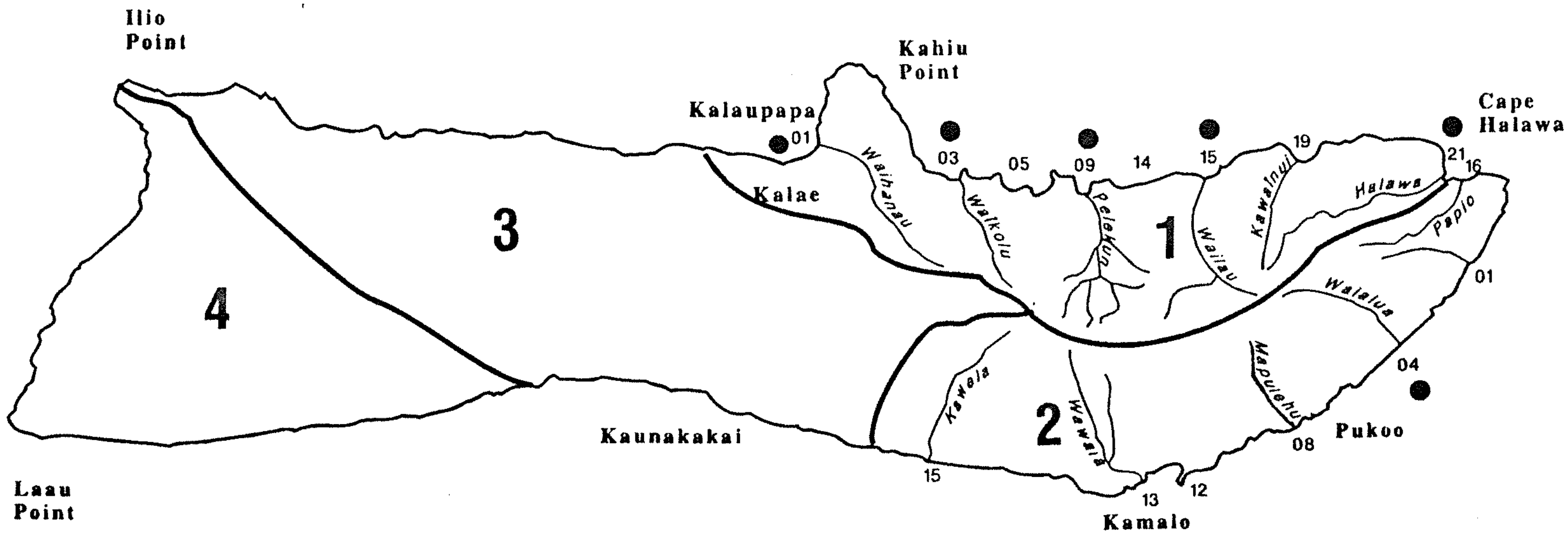


OAHU
Island Code - 3

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Map 8 Candidate Streams for Protection



4-1-01	Waihanau	Cu	Cu
4-1-03	Waikolu	AqRc	Aq
4-1-09	Pelekunu	AqRpCuRc	AqCu
4-1-15	Wailau	AqCuRc	CuRc
4-1-21	Halawa	AqCuRc	AqCuRc
4-2-04	Waialua	RcCu	Rc

MOLOKAI
Island Code - 4

Hawaii Stream Assessment

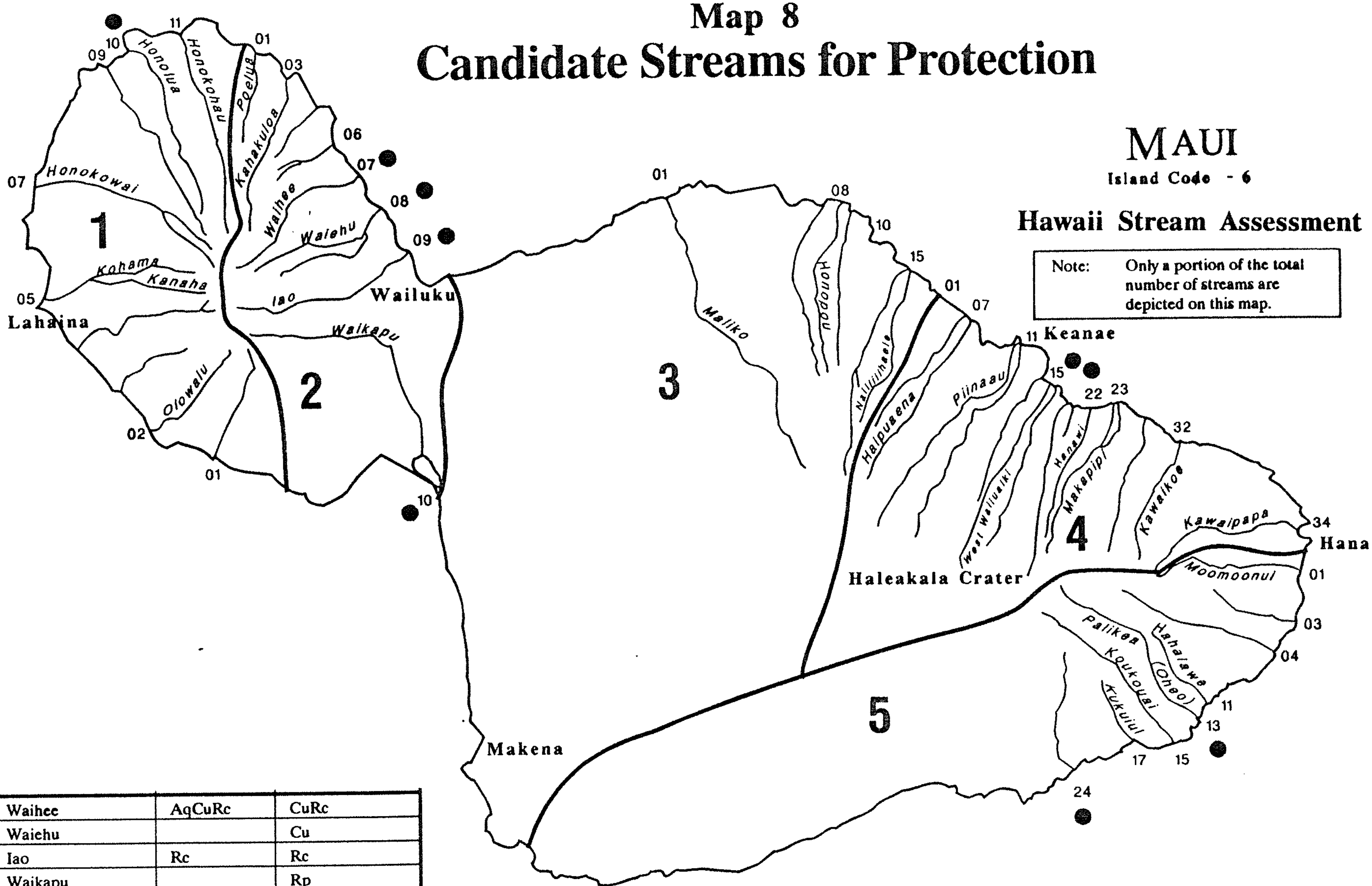
Note: Only a portion of the total number of streams are depicted on this map.

Map 8
Candidate Streams for Protection

MAUI
Island Code - 6

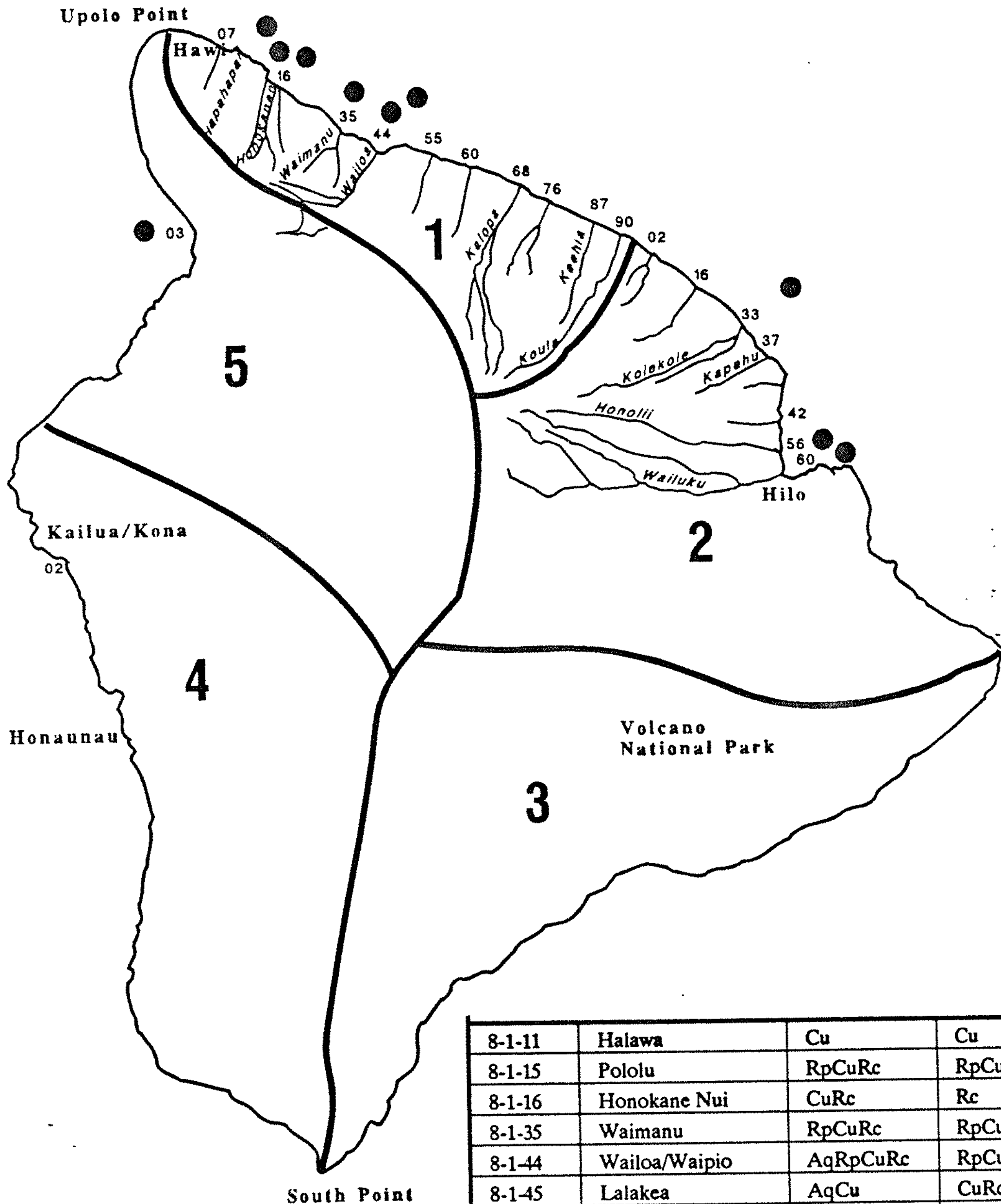
Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.



6-2-07	Waihee	AqCuRc	CuRc
6-2-08	Waiehu		Cu
6-2-09	Iao	Rc	Rc
6-2-10	Waikapu		Rp
6-4-11	Piinaau	AqRcRp	AqCu
6-4-18	Waiohue Gl.	RcAq	Aq
6-4-22	Hanawi	AqRpRc	AqRp
6-5-13	Oheo Gl.	AqRpRc	AqRc
6-5-24	Manawainui	AqCuRc	

Map 8 Candidate Streams for Protection



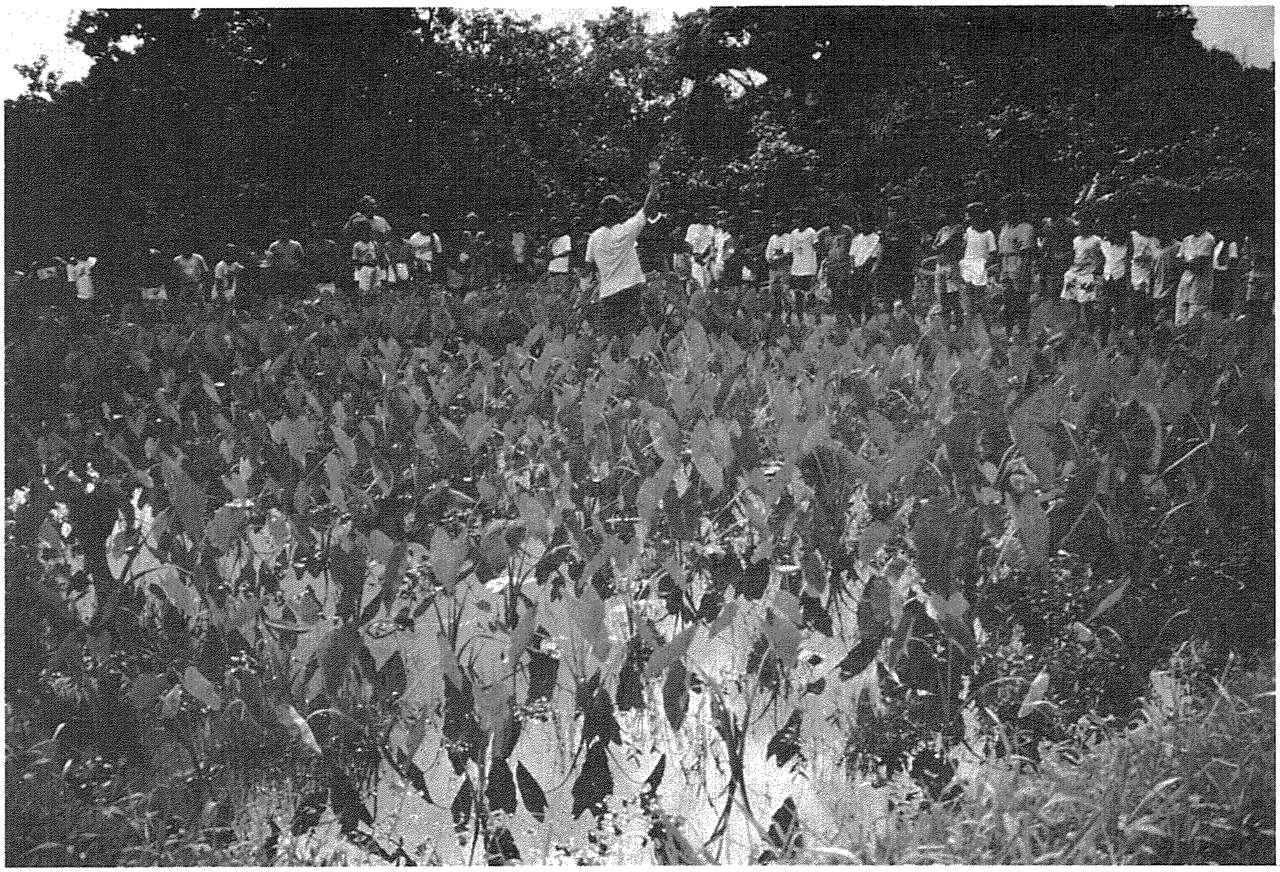
8-1-11	**Halawa**	Cu	Cu
8-1-15	Pololu	RpCuRc	RpCu
8-1-16	Honokane Nui	CuRc	Rc
8-1-35	Waimanu	RpCuRc	RpCuRc
8-1-44	Wailoa/Waipio	AqRpCuRc	RpCu
8-1-45	Lalakea	AqCu	CuRc
8-2-33	Kolekole	AqRc	Rc
8-2-56	Honolii	AqRpRc	Aq
8-2-60	Wailuku	RpRc	Rc
8-5-03	Waikoloa	Cu	Cu

HAWAII
Island Code - 8

Hawaii Stream Assessment

Note: Only a portion of the total number of streams are depicted on this map.

Future Actions



Future Actions

The Hawaii Stream Assessment was a two-year project designed to bring relevant stream-related information together in one place. This has been accomplished to the degree possible given the project limitations. Through this process a number of possible future actions have been identified and recommended:

- **maintain and enhance the HSA database;**
- **develop long-term stream management strategies;**
- **institute interim actions to preserve management options.**

These recommended actions reflect study team opinion. While they are based on HSA findings, there are other actions that could be developed to help protect and manage Hawaii's stream resources.

Maintain and Enhance the Hawaii Stream Assessment

The Hawaii Stream Assessment is an important building block for use in long-term stream management. However, the information needs to be refined, periodically updated and expanded to ensure its ongoing usefulness. The following CWRM or DLNR actions can help achieve this goal.

° Initiate studies, workshops and development of master plans.

Monitoring. It is suggested that the CWRM ask the U.S. Geological Survey (USGS) to take the lead in a Monitoring Network Analysis. The purpose of this analysis should be to identify objectives of the state's water flow and quality monitoring, design a program based on these objectives and describe funding to implement it. Participants should include the appropriate DLNR divisions, especially DAR, DWRM, DOFAW, Department of Health, U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and Soil Conservation Service, Hawaiian interests, major water users, county water departments, and environmental groups.

Watershed Management. As the major landowner and custodian of conservation land in Hawaii, the DLNR might initiate a watershed roundtable to identify problems and develop a research and management plan for watersheds. Besides appropriate DLNR divisions, participants might include, the Department of Health, the U.S. Soil Conservation Service and U.S. Fish and Wildlife Service, and other major landowners.

Aquatic Studies. The Division of Aquatic Resources, DLNR, should establish a protocol for updating the aquatic resource database. The DAR might also take the lead in developing a five-year master plan for aquatic research in cooperation with others interested in study and management of this resource, such as U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers and University of Hawaii.

The CWRM might urge the USFWS to take the lead, with water development companies and appropriate agencies, in a cooperative research project to quantify biological impacts of stream restoration and stream dewaterment.

Hydroelectric Masterplan. The CWRM should commission a statewide hydroelectric masterplan which balances river protection with hydroelectric power.

° **Dedicate a CWRM staff position specifically and exclusively to conservation. The responsibilities of the "stream keeper" would include:**

a. Maintain HSA database by periodically updating data from DLNR divisions, and other appropriate state and federal agencies;
b. Prepare reports with a conservation point of view for CWRM; and
c. Sponsor and encourage public involvement in stream conservation.

° **Request the Office of State Planning to make streams a theme of the state Geographic Information System.**

While the HSA database will be useful in helping OSP locate stream data, it does not contain geographic information.

Develop Long-Term Stream Management Strategies

° **Adopt a Hawaii Stream Policy which provides that the important natural, cultural and recreational values of Hawaii's streams are protected.**

The state of Hawaii should adopt a stream management policy which states the intent of the citizens of Hawaii to have their stream resources managed so that the natural, cultural and recreational values of those streams are either unimpaired or enhanced by future actions affecting stream resources. This does not preclude "development" of stream resources but it implies that any action which is detrimental to a stream must be accompanied by some other action which enhances the stream resources.

° **Establish a Hawaii Stream Plan with general guidelines and a Protected Streams Program.**

The implementation of the Hawaii Stream Policy would be through the Hawaii Stream Plan, which would consist of several programs including General Guidelines for all streams and several levels of protection for designated streams.

General Guidelines

- Development that affects a stream should be reviewed with reference to HSA resource assessments and special areas. A checklist such as Figure 4 should be developed to facilitate this review.
- Offstream water development should be balanced with preservation of natural, cultural and recreational values.
- Appropriate types of action to consider for watershed management include stream corridor setbacks, increased floodplain protection, restrictions on channelization, noxious species control, and no net loss of wetlands and stream habitats.
- Minimum instream flows should take aquatic biota into account.
- Control of non-point source pollution from the entire watershed including urban areas should be given high priority.
- Each island and urban population center should have publicly accessible stream-related recreation.
- Streams with substantial recreational use should be targeted for water quality enhancement.

Protected Streams Program

Now that a preliminary identification of streams appropriate for protection has been completed, a stream protection program should be established. HSA developed six approaches toward the identification of streams to be considered for protection. These are outlined in the Candidate Streams for Protection chapter. A process by which the public can nominate additional streams for consideration for protection needs to be devised.

The study team analyzed the six approaches and recommends the Commission consider three of these in combination to form a Hawaii State Protected Streams Program: Approach 2 (Diverse or Blue Ribbon Resources), Approach 3 (High Quality Natural Resources), and Approach 4 (Aquatic Districts). Approach 6 (National Wild and Scenic Rivers) is recommended where it is deemed appropriate to protect the State from Federal action.

Approaches 1 and 5 are not recommended. Using Approach 1 (all streams with an Outstanding value in any resource area), about half of all streams would be eligible for protection. The study team rejected this approach as lacking in sufficiently discriminating criteria to provide the basis for a meaningful stream protection program. Using Approach 5 (all free-flowing streams with the most outstanding values) eliminates almost all of Hawaii's largest streams, many of which have been identified as having the most outstanding values, from consideration for protection. The study team rejected this approach being too discriminating to provide the base for a meaningful stream protection program.

Approach 2 identifies streams which are important based on the diversity of resources or blue ribbon values. These should be the focus for a range of management and planning activities. Management decisions should be based on natural resource conservation standards and priority given to instream values. This would include discouraging channelization, hydroelectric development and diversions which would detract from natural values, and when allowed, a sufficient instream flow should be required.

Approach 3 identifies streams with outstanding aquatic and riparian values which should receive full watershed protection (from the mountains to the ocean) as Kapu streams. Using the strict criteria developed in approach 3 very few streams qualify, none on Oahu. We recognize that the quality of Oahu's resources have been severely degraded and therefore it may be unfair to compare them with the stream resources on other islands. However, new criteria could be developed comparing Oahu's streams only, so that at least one stream on that island could be considered for Kapu status.

Restrictions placed on Kapu streams should include all man-made modifications, including alteration for agricultural use, hydroelectric, storage, diversion, aquaculture, channelization. Span bridges could be considered as appropriate only if they do not interfere with the free flow of the stream. Development in the immediate watershed which would produce non-point or point source pollution or which would deplete the surface water should be discouraged. Control of noxious species in the watershed would be emphasized. Stream corridor maintenance would receive high priority. Restrictive State zoning might be an appropriate level of protection for Kapu streams and their associated watersheds.

Approach 4 discusses the concept of aquatic stream districts. Aquatic biologists think that clusters of streams may provide values and habitats that single isolated streams do not. Stream districts might be identified and management for aquatic resources developed.

Approach 6 suggests that streams appropriate for protection under the National Wild and Scenic Rivers Act be identified. CWRM should consider determining which streams are eligible and recommending them for designation.

Institute Interim Actions to Preserve Management Options

Several measures can be taken to preserve management options until long-term Stream management policies are developed.

- **Declare a moratorium on development of significant streams.**

  Development of a number of streams with significant resources is proposed or under consideration. To preserve management options candidate Kapu (approach 3) and possibly blue ribbon streams (approach 2) could be given immediate protection.

- **Use HSA General Guidelines in the interim, especially;**

  - Development which effects the stream should be reviewed with reference to HSA resource assessments and candidate streams for protection areas. A checklist such as Figure 4 should be developed to facilitate this review.
  - Offstream water development should be balanced with preservation of natural, cultural and recreational values.

- Consider stream corridor setbacks, increased floodplain protection, restrictions on channelization, noxious species control, and no net loss of wetlands and stream habitats.

Figure 4. Stream Impact Review

Project Identification Number:

Proposed by:

Project Description:

Address:

Phone:

Contact:

Quad Map:

Stream, tributaries, and HSA Stream Code:

Other streams affected:

(fill out a form for each stream affected)

Summary and Recommendations

Importance of stream from a statewide, islandwide and hydrographic unit/general area perspective.

Additional comments:

Recommendations:

DLNR Staff Reviewer and date of review

Physical Characteristics

Continuous or Interrupted flow:

Modifications

- Diversions:
- Channelization:
- Hydroelectric:

Monitoring

- Water Quality:
- Gaging:

(gage number, active, flow, years of record, diverted above gage etc.)

Is monitoring needed?

Special Areas

(List each one)

Parks

Habitats-- preserves, reserves, refuges, etc.

Estuary/Embayment

Wetlands

Designated Area

Research, education, nature study

Historic sites/districts

Waterfalls

Aquatic

HSA Rank	Reason for rank

Data Quality

Revised Rank	Reason

Significance of the resource

- In the State
- On the island
- Within the hydrographic unit or general area

Potential to enhance or reestablish the resource

Possible effects this development will have on the resource

Other considerations

Cultural

HSA Rank	Reason for rank

Data Quality

Revised Rank	Reason

Significance of the resource

- In the State
- On the island
- Within the hydrographic unit or general area

Potential to enhance or reestablish the resource

Possible effects this development will have on the resource

Other considerations

Recreation

HSA Rank	Reason for rank

Data Quality

Revised Rank	Reason

Significance of the resource

- In the State
- On the island
- Within the hydrographic unit or general area

Potential to enhance or reestablish the resource

Possible effects this development will have on the resource

Other considerations

Riparian

HSA Rank	Reason for rank

Data Quality

Revised Rank	Reason

Significance of the resource

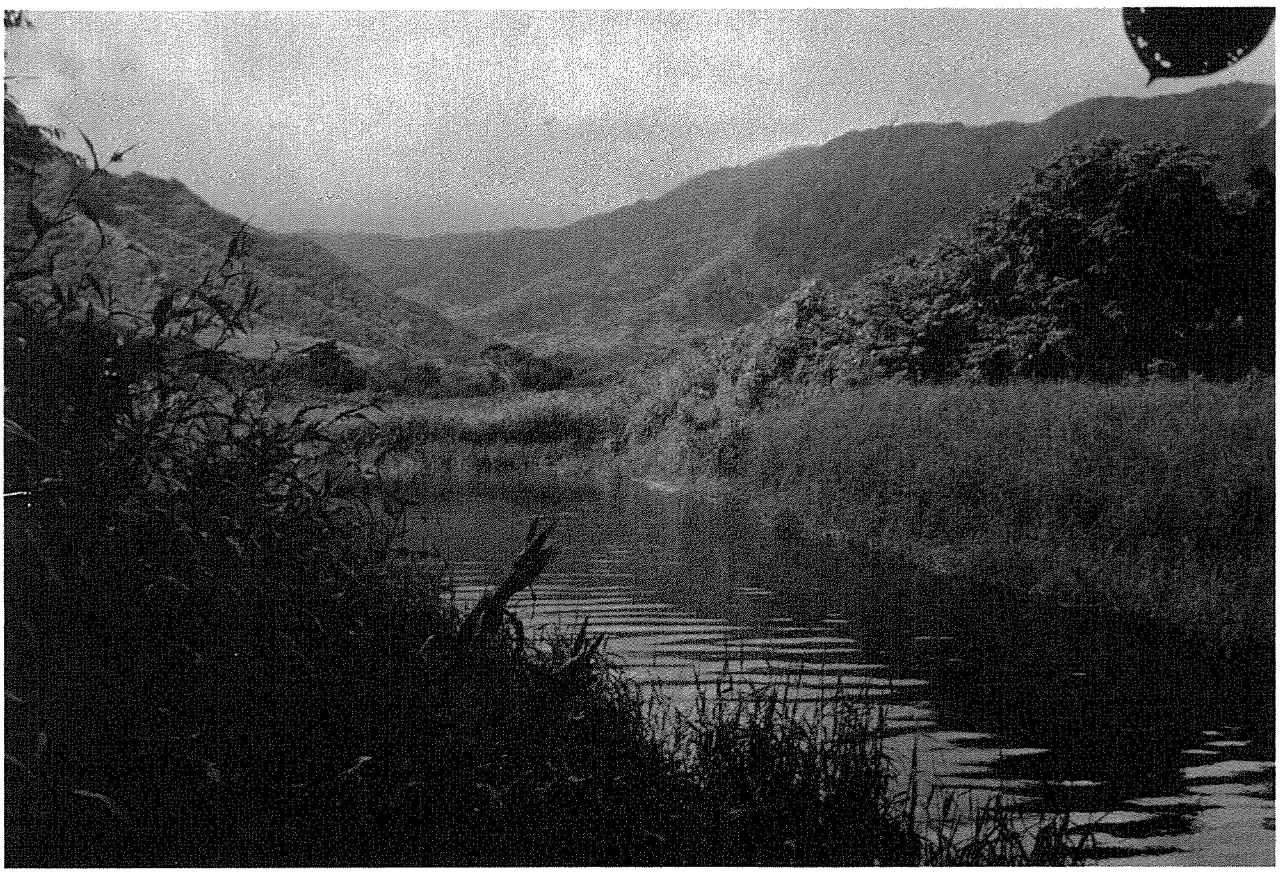
- In the State
- On the island
- Within the hydrographic unit or general area

Potential to enhance or reestablish the resource

Possible effects this development will have on the resource

Other considerations

Database Overview



Database Overview

The Hawaii Stream Assessment database is a compilation of information collected during the Hawaii Stream Assessment project. The database developed throughout the project and is expected to be expanded and updated periodically by the National Park Service's Cooperative Park Research Unit and the state Department of Land and Natural Resources.

Information was entered into the database using dBase IV and can be made available to users on diskettes in either dBase IV or ASCII formats. A detailed database guide, "The 1990 Guide to the Hawaii Stream Assessment Database," accompanies each set of diskettes. The guide describes the fields in the databases, defines any codes used, and notes the bibliographic source. Related information is cross-referenced whenever appropriate.

This section is intended to give the reader of this technical report an overview of the contents of the database. Generally, each resource area has at least two databases, one very detailed and usually one summarized with assessment data. The physical data is contained in many more databases. The databases are entirely relational, primary linked by the stream code. The Master.dbf includes all stream codes found in every database and must be used to link any other database files together (Figure 5).

Physical Characteristics

Master.dbf This .dbf contains all of the stream codes used in any of the other databases. This includes the codes and names for tributaries and streams that were thought to be perennial at one time. The "finallist" field indicates those streams used in the assessment processes. **This database should always be used to link any other two databases together.** See the "1990 Guide to the Hawaii Stream Assessment Database" for more information.

Dbasic.dbf Contains name, tributary location, map, size, and perennial stream classification information.

Gaging.dbf All USGS gaging data such as gage number, average and median flow, discharge data type, diversions above gaging station, years and quality of record and non-USGS predicted natural median flow are included in this database. The gage number field links this database with the Ditches.dbf.

Ditches.dbf This database contains much of the same information contained in the gaging database but instead of being stream coded, it is associated with a ditch. The gage number links this database with the gaging database.

Hydro.dbf The hydroelectric developer and project name and the associated ditch or stream name can all be used to identify a proposed or existing hydro project. The annual electrical output, the potential electrical capacity, and the average and median flows are recorded when available.

Modifications.dbf Channelization type and length compose most of this database. Dam height and impound capacity and the presence of diversions are also noted.

Special.dbf Special areas encompass estuaries, embayments, wetlands, parks, reserves, preserves, managed areas, research and educational sites, and those areas with special designations.

Supply.dbf Water supplied by streams for municipal and plantation uses is outlined here. The names of the sugar companies using stream water are also given.

WQ.dbf Water quality information type, data of collection and the source of that information are listed here.

Aquatic Resources

Aq.dbf This .dbf contains detailed aquatic data. For each stream, the scientific and/or common name of the species observed, the abundance and year of observation are listed. This .dbf contains more than 1,000 records, as there are often several records for one stream.

Aqassess.dbf This .dbf contains summary data for all streams as well as some detailed information on native species. Summary data includes number of native and introduced species, the diversity of species, the quality of the information and the HSA rank.

Cultural Resources

Archaeo.dbf All of the archaeological information in this database was provided by the state Historic Preservation Division. It includes the number of sites, amount of survey coverage, ability to predict what sites might be found in a location, the significance of low density sites, and the overall sensitivity of a stream to development.

Historic.dbf This database contains all of the historic information collected. The presence of national and state historic register sites are noted. Bridge name and inventory rank (or score if one was assigned) are also included.

Modern.dbf The acreage and number of people who declare they grow taro with water from a particular stream and the estimated acreage of taro cultivated are in this .dbf.

Recreation Resources

Rec.dbf This file contains data on the quality and recreation opportunity spectrum category for camping, hiking, swimming, boating, fishing, parks and hunting experiences. The quality of educational programs and the quality and vantage point for scenic views are also included, as are some data for intermittent streams.

Recassess.dbf This .dbf contains summary data for all streams including those later deleted from the assessment process. The number of high quality experiences and total experiences, the activity types, HSA regional rank, and HSA state ranks are included.

Recmemo.dbf All detractions, access problems, unique features and high quality opportunities are described in memo fields in this database.

Riparian

Rip.dbf Wetlands, recovery habitat, protected riparian areas, percent of native forest, and detrimental organisms are listed.

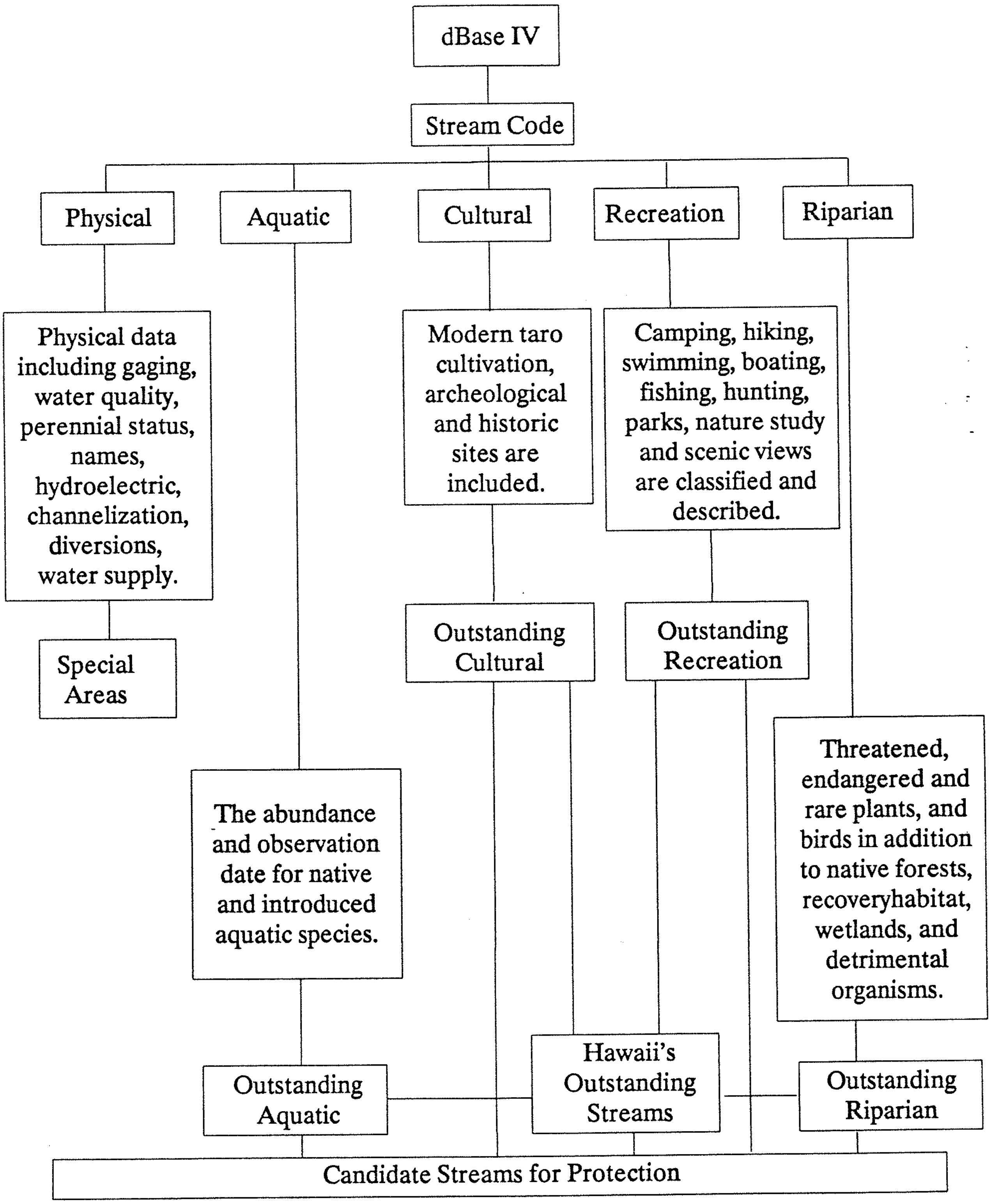
Plants.dbf All rare stream-related plants and their Nature Conservancy Hawaii Heritage Program database element code, the general location the plant was observed, and the last year seen are indicated. This .dbf contains one record for each plant observed on a stream.

Birds.dbf All threatened and endangered stream-dependent and stream-related forest birds and their Nature Conservancy Hawaii Heritage Program database element code, the general location and last year of observation are indicated. This .dbf contains one record for each species of bird observed on a stream.

For More Information

The Hawaii Stream Assessment Database can be made available on diskette with the accompanying "Guide to the Hawaii Stream Assessment Database" from the DLNR Division of Water and Land Development. A compiled version of this database which can be queried without knowledge of a database program is in preparation and may be available in 1991. The HSA database may be linked to the state of Hawaii Geographic Information System in the future.

Figure 5
Hawaii Stream Assessment Database Diagram



Questions from the Public

Questions from the Public

The Hawaii Stream Assessment held six public information meetings throughout the state between September 17 and 28, 1990. Written comments were accepted until the end of September. Most of the new information was given to DWRM for processing into the database. When appropriate, revisions were made for this final report, especially in the candidate streams for protection and future action chapters. A number of questions that were raised are summarized and answered below.

What are "beneficial instream uses?"

The State Water Code, Chapter 174C-3 says:

"Instream use" means beneficial uses of stream water for significant purposes which are located in the stream and which are achieved by leaving the water in the stream. Instream uses include, but are not limited to:

(1) Maintenance of fish and wildlife habitats;

(2) Outdoor recreational activities;

(3) Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;

(4) Aesthetic values such as waterfalls and scenic waterways;

(5) Navigation;

(6) Instream hydropower generation;

(7) Maintenance of water quality;

(8) The conveyance of irrigation and domestic water supplies to downstream points of diversion;

(9) The protection of traditional and customary Hawaiian rights."

Note: The HSA did not include uses described in (5) or (9) in its scope of work.

Why isn't my stream included on the HSA list?

HSA developed the list of 376 perennial streams using maps, reports and first-hand knowledge of the project participants. If your stream is not included it could be a tributary of one of the HSA streams, it might be intermittent (sometimes dry), or we may have missed it. The streams recommended for inclusion during public review are indicated on the USGS maps as tributaries or as intermittent, correctly or not. A review process for future additions to the perennial list needs to be devised.

What is the Wild and Scenic Rivers Act?

According to a 1988 report by the organization American Rivers, "The emphasis of the Wild and Scenic Rivers Act is to protect our most outstanding rivers from inundation by federally-supported dams and hydroelectric projects and to have stream courses remain free from channelization, diversions and similar alterations." Federal Wild and Scenic designation does not adversely affect existing land uses along a river because they are an integral part of the river corridor and its history. Designation may lead to some restrictions (if local governments adopt them) on major new building development on privately owned land and to land use activities on federal land if they would be destructive to major aspects of the river environment. While designation does affect activities on federal land there is no power to force state and local governments to zone land for conservation.

Why wasn't field work done?

The Hawaii Stream Assessment was designed as a broad based inventory and assessment of stream-related resources based on existing information in published documents or government files. A major exception was recreation for which we had to develop the information and where we used a committee consensus approach for each island. The process used for HSA is efficient in that it suggests where fieldwork is needed.

What was the purpose of the Hawaii Stream Assessment?

The purpose of the HSA was to provide the CWRM with information to help them to "identify rivers or streams, or a portion of a river or stream, which appropriately may be placed within a wild and scenic river system, to be preserved and protected as part of the public trust."

Why haven't economic uses of streams been assessed?

First, streams appropriate for protection are those with the best instream resources, not those with the highest economic use. It was also determined early in the HSA that the water use certification database that would indicate economic uses would not be complete in time and therefore could not be used.

Since streams change significantly from the mountains to the ocean why weren't streams considered in sections?

We attempted to segment streams using various criteria, e.g. segments between major tributaries, above and below diversions, lowland vs. upland, above and below the 1,000 ft contour. All approaches evaluated had significant detractions and there was no strong argument in defense of any of them. Drew Parkin, a national expert on streams recommended that we consider streams as entire units because of their short length and, more importantly, several native aquatic animals depend on the entire length of the stream to complete their life cycle.

If the HSA is a reference document why are recommendations provided?

The CWRM asked us to develop some recommendations after our initial presentation of the draft report and associated materials.

What is the next step?

Continue updating the database incorporating authenticated new or additional information, encouraging research to fill in the gaps, and linking the database into the state's computerized geographic based information system.

How can or will the HSA be used?

HSA can and should be used to learn more about Hawaii's streams in general or the resources associated with specific streams. It will help to clarify what information exists and/or needs to be collected. Streams can be reassessed by applying the criteria to the continuously updated database. It should be the starting point of any stream-related use or management planning activity.

How can I gain access to or get a copy of the database?

A "user friendly" version of the database is being prepared through the assistance of the National Park Service, and should be available in 1991. Inquiries should be directed to the HSA Streamline.

How will this conservation-biased document be balanced for decision-making?

Water users, landowners and others with economic interests should be sure to present their perspective during any decision-making process.

What relation does HSA have to the instream flow standards?

The database consolidates information from a wide array of sources that could contribute to the establishment of instream flow standards.

Why haven't "traditional and customary Hawaiian rights" been inventoried?

This is a separate and equally daunting task. We determined early in the scoping of this project that it was beyond our capabilities to even define these rights. Hopefully, the inventory of the resources themselves will be some help to this important work.

What about land ownership, land use and zoning?

Indeed, very important, but not included in the report primarily because this spatial information is best handled through mapping, which was beyond the scope of HSA. This emphasizes our point that streams need to be a theme of the state's GIS.

I live along one of the candidate streams for protection. If it is designated for protection will my land be condemned? Would additional offstream uses of water be allowed?

The state's "wild and scenic" protection program can be designed in many ways, to allow or not to allow degrees of diversion, to differ from one stream to the next, to do almost anything. As an riparian owner or user, you will be interested not only in the use of your stream, but in its protection. Your participation in helping to design a stream protection program is critical to its success.

I don't think that stream should be ranked outstanding!

The four resource committees reached their decisions using existing information and criteria that they developed. Since the criteria is subjective, so is the ranking as the committees will be the first to agree. However, the committees did their best with the information available. It is unlikely that everyone will agree with all the rankings.

Isn't this really a plot to take my water, condemn my land, and settle the Hanapepe water rights case?

No.

What happened to the Kapu streams?

Kapu streams are suggested in Approach 3, Candidate Streams for Protection. The data indicates a number of streams would be candidate Kapu streams based on natural resources (Table 1).

You do not have enough information to make recommendations!

The study team believes that the existing data, while limited, is sufficient to conclude that the state's surface water resources are limited and fragile and need protective management now. Recommendations for future action are based on this conclusion, along with calls for more study and data.

What is DWRM?

The Division of Water and Land Development (DOWALD) has recently been renamed Division of Water Resource Management (DWRM).

The data are wrong or missing. What is the process for changing or updating the database?

This report is a "snapshot" of the presently recorded information, some of it is already obsolete. It is anticipated that the database will be periodically updated with verified information.

Write to:
HSA Streamline
Division of Water Resources Management, DLNR
P. O. Box 621
Honolulu, Hawaii 96809