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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

JUN 14 2005

MEMORANDUM

TO: Genevieve Salmonson, Director
Office of Environmental Quality Control

FROM: Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

SUBJECT: Final Environmental Assessment (FEA)/Finding of No Significant Impact (FONSI) for Conservation District Use Application (CDUA) HA-3222 to construct Hawaii Tropical Botanical Garden's 800 Square Foot Aviary, South Hilo, Hawaii, Subject Parcels TMK's: (3) 2-7-009:002, 006, 010 and (3) 2-7-010:022

The Department has reviewed CDUA HA-3222 and the Final Environmental Assessment (FEA) to construct Hawaii Tropical Botanical Garden's 800 Square Foot Aviary, South Hilo, Hawaii, Subject Parcels TMK's: (3) 2-7-009:002, 006, 010 and (3) 2-7-010:022. The Draft Environmental Assessment (DEA) was published in OEQC's April 23, 2005 Environmental Notice for the subject project. The FEA is being submitted to OEQC. We have determined that this project will not have significant environmental effects, and have therefore issued a FONSI. Please publish this notice in OEQC's upcoming July 8, 2005 Environmental Notice.

We have enclosed four copies of the FEA and CDUA HA-3222 for the project. The OEQC Bulletin Publication Form is attached. Comments on the draft EA were sought from relevant agencies and the public, and were included in the FEA.

Please contact Dawn Hegger of our Office of Conservation and Coastal Lands staff at 587-0380 if you have any questions on this matter.

Enclosures

cc: Hawaii Tropical Botanical Garden

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OFC. OF ENVIRONMENTAL QUALITY CONTROL

2005-07-08 HI FEA NEW AVIARY AT HAWAII TROPICAL BOTANICAL GARDEN

Final

ENVIRONMENTAL ASSESSMENT

AMENDMENT TO CONSERVATION DISTRICT USE PERMIT HA-1447A FOR NEW AVIARY AT HAWAII TROPICAL BOTANICAL GARDEN

Alakahi, Kahalii and Onomea, South Hilo, Hawaii
TMK: (3)2-7-9:02, 06 and 10, 2-7-10:22

Applicant:
HAWAII TROPICAL BOTANICAL GARDEN
P.O. Box 80
Papaikou, HI 96781

For Submittal to
State of Hawaii
Department of Land and Natural Resources

May 30, 2005

ENVIRONMENTAL ASSESSMENT

AMENDMENT TO
CONSERVATION DISTRICT USE PERMIT HA-1447A
AT
HAWAII TROPICAL BOTANICAL GARDEN

Table of Contents

1. INTRODUCTION

1.1 Identification of the Applicant

The applicant is Hawaii Tropical Botanical Garden, a non-profit Hawaii corporation, that has been designated as a tax exempt public charity under Section 501(c)(3) of the Internal Revenue Service Code (the "Applicant"). The Applicant's address is P.O. Box 80, Papaikou, HI 96781. The Applicant is the owner of the property involved in the subject project, designated by State of Hawaii Tax Map Key Numbers ("TMK"): (3)2-7-9::2, 6 and 10 and 2-7-10:22. The Applicant's ownership of the property is evidenced by the following documents:

A. Deed dated December 6, 1993 from Daniel J. Lutkenhouse, Grantor, to Hawaii Tropical Botanical Garden, Grantee, recorded in the Bureau of Conveyances of the State of Hawaii as Document No. 93-214134, for TMK: 2-7-10:22.

B. Quitclaim Deed, dated June 30, 1994, from Bishop Trust Company, Limited, Trustee, Grantor, to Hawaii Tropical Botanical Garden, Grantee, recorded as Document No. 94-119012 for TMK: 2-7-9:06 and 10.

C. Deed dated December 22, 1995, from Daniel J. Lutkenhouse, Trustee, Grantor, to Hawaii Tropical Botanical Garden, Grantee, recorded as Document No. 96-004764 for TMK: 2-7-9:02.[1]

1.2 Project Summary

The Applicant is seeking to amend State Conservation District Use Permit ("CDUP") No. HA-1447A issued by the State of Hawaii, Board of Land and Natural Resources ("BLNR") on September 27, 1996. This authorized certain immediate improvements and established a master plan for future improvements to and expansion of the Garden as it was originally authorized and established by State Conservation District Use Permit No. HA-1447 on August 4, 1982.

The improvement proposed by this Project involves the demolition of three existing aviaries that were approved by BLNR with CDUP HA-1447, and construction of a single large aviary occupying essentially the same space and serving the same purpose.

1.3 Identification of Approving Agency

This environmental assessment is being submitted in conjunction with an

[1] TMK 2-7-9:02 had previously been leased to the Applicant under a long term lease, which was canceled upon conveyance of the property to the Applicant by that certain Cancellation of Amended Lease Agreement dated December 22, 1995, recorded as Document No. 96-004763.

Application to BLNR to amend CDUP HA-1447A in accordance with Sections 13-5-22(b) P-9, and 13-5-24(c) R-5 of the Department of Land and Natural Resources ("DLNR") Administrative Rules. The Planning Department, County of Hawaii, in its response to the Applicant's Special Management Area (SMA) Use Permit Assessment Application (SMAA 03-08), dated July 3, 2003, has determined that this Project qualifies for an SMA exemption (Exhibit 1).

1.4 Agencies Consulted in Making Assessment

In September 2003, twelve federal, state and county agencies and eight community organizations were sent letters from the Applicant for comments on the proposed Project. A list of those agencies and organizations consulted, the consultation letter and any responses are attached as Exhibits 2 through 4, respectively.

2. PROJECT DESCRIPTION

2.1 Location

The Project Area is situated at Onomea Bay, at Alakahi, Kahalii and Onomea, South Hilo, Hawaii (See Figure 1, Location Map). The property on which the project is located is designated by TMK Nos: (3)2-7-09:2, 6 and 10, and 2-7-10:22, and contains a total area of approximately 38.555 acres. (See Figures 2 and 3, Tax Map Plats 2-7-9 and 2-7-10). The Project Area is Located on the makai or northeasterly side of the Old Mamalahoa Highway, also known at the "Four Mile Scenic Route," approximately two miles north of the Hawaii Belt Road/Old Mamalahoa Highway intersection, and extends to the shoreline at Onomea Bay.

2.2 Existing Uses and Activities

Since 1982, the Applicant has been operating is arboretum and botanical garden on the 17 acre portion of the Project Area, designated as TMK: 2-7-9:02. At present, improvements to the Garden include extensive landscaping, walkways with numerous benches for resting, tool sheds, a greenhouse, two ponds, three small aviaries, bird perches, two restrooms, three rain shelters, two bulletin boards, an entrance gate, a 500 foot long elevated boardwalk, electrical and telephone lines, informational signage and two shoreline access trails, delineated by 6' chain link fencing that cut directly through the center of the Project Area. These access trails are open to the general public as a pedestrian access trail on a twenty-four hour basis, seven days per week. (See Figure 4, Site Plan of Existing Improvements). An unimproved pedestrian shoreline access trail within the Project Area on TMK: (3)2-7-10:22, known as the Donkey Trail, is open to the public on a twenty-four hour basis, seven days per week. More than 2,000 species, most of which are exotic, are found in the Garden's collection of over 10,000 different plants. Also found in the Garden are koi in one pond known as Lily Lake, and six macaws that reside in the previously mentioned aviaries.

More than 85,000 people visit the Garden annually, with most of these visitors paying an admission fee to the Garden. A visitor center is located on a 5 acre parcel that lies directly across the Four Mile Scenic Route from the entrance gate to the Garden (TMK: (3)2-7-010-014). The visitor center contains the Garden Gift Shop, Onomea Museum and administrative offices.

2.3 Permits Issued for the Project

Permits for all existing improvements within the Project Area have been approved by the BLNR. These are allowed under CDUP HA-1447, issued on August 4, 1982, an amendment to CDUP HA-1447 issued on March 24, 1994, CDUP HA-1447A issued on September 27, 1996 and CDUP HA-3161, issued on February 20, 2004. The original CDUP authorized the development of an arboretum and botanical garden utilizing a mini bus system. The landscaping, walkways, rain shelters, restrooms and fencing were constructed under the original permit, with site plan approval being issued by the BLNR chairperson for the structures, including the restrooms and the trail fencing. The 1994 amendment to the CDUP granted after-the-fact approval for the bird aviaries, the bird exhibition stands, the two ponds and signage, including "no-trespassing" signs. The 1996 amendment to the CDUP authorized a new Garden entrance, new access and vista trails, bulletin board, rain shelters, rest benches, utility poles and lines, fencing, signage and landscaping. The 2004 amendment to the CDUP granted after-the-fact approval for paving the portion of the public shoreline access trail over which the Applicant's clients must walk to access all portions of the Project Area.

SMA minor permits were also issued for the existing improvements within the Project Area under SMA Minor Permit No. 79-7, issued on February 2, 1979 for land clearing for the establishment of pathways and trails and for topographical purposes; SMA Minor Permit No. 82-28 issued on July 2, 1982 for the establishment of an arboretum and botanical garden and related improvements; SMA Minor Permit No. 88-20 issued on October 18, 1988 for the construction of two small restrooms and a cesspool; SMA Minor Permit issued on March 11, 1994 for the construction of a new rain shelter, and for the retention of a zoological garden that included macaws, flamingos, ducks and a related pond, the retention of an aviary consisting of three individual aviaries that house the Applicant's macaws and wooden exhibition stands, the retention of the Lily Lake and retention of portable "no-trespassing" signs; SMA Use Permit No. 140, issued on November 29, 1995 for a Master Plan for Expansion and Improvement the Botanical Garden and Arboretum to include entrance, trails, shelters and related improvements; and finally SMA Use Permit Application, SMAA 03-08, issued on July 3, 2003 qualifying the current proposal to demolish three existing aviaries and the construction of a single aviary in their place as exempt from SMA approval.

2.4 Proposed Uses and Activities

The Applicant proposes to remove the existing three aviaries that were

constructed as approved under CDUP 1447 and, in their place, construct a single large aviary that will occupy essentially the same space (Exhibit 5). Each of the existing aviaries measures eight feet wide by eight feet deep by eight feet high, occupying 192 square feet. They are arranged in an "L" configuration, with separation space between them of eight feet so that they occupy a total area of 38 feet long by 20 feet wide, or 760 square feet. The structural integrity of these aviaries has deteriorated over the years and requires attention.

The new aviary is proposed to be 40 feet long by 20 feet wide (800 square feet) and 17 feet high. The structure would be permanently footed in a four-inch thick concrete foundation that would extend one foot either side of the exterior walls, allowing for landscaping inside and surrounding the aviary. Plant species selected would be essentially the same materials that are already used for landscaping throughout the Garden, with the aim to blend the structure into the surrounding rain forest so that it will be unobtrusive and negligibly noticeable. The structural framework incorporates post and beam aluminum framing, using 1-inch square black anodized aluminum tubing. Mesh enclosure panels are framed with 1-inch square black anodized aluminum tubing that is bolted to the framework. The mesh itself is 1" x 1" 12.5 gauge GAW (galvanized after weaving) wire, powder-coated black.

This project is proposed to provide state-of-the-art housing for the Applicant's six macaws. It will be constructed by custom caging specialists Corners Limited, a company from Kalamazoo, Michigan, with an excellent reputation for having constructed world-class aviaries at many of the finest zoological parks and botanical gardens across the United States.

2.5 Timetable for Development

The Applicant proposes to initiate work on the project upon receipt of required permits from the State. It will take three to four months for the contractor, Corners Limited, to prefabricate the structure and ship the structure to Hilo. Once here, the contractor has stated that they can complete construction in four weeks. Therefore we would anticipate completion of the project within six months of being granted the permits necessary.

2.6 Objectives, Needs and Alternatives Considered for the Project

The Applicant has the following objectives for the Project:

(a) To provide a state-of-the-art permanent structure to replace the aged and deteriorating existing structures.

(b) To provide for better use of the space currently occupied by the existing aviaries such that the Applicant's macaws will have sufficient space to fly and live a higher quality of life in captivity.

(c) To provide an improved display for enhancement of the Applicant's visitor experience and education.

There is a need for this Project for several reasons. The present aviaries are deteriorating to the point where escape by the macaws is becoming an increasingly likely possibility due to rot of the wooden framework as well as rust deterioration of the wire mesh. In addition, the present aviaries do not allow the inhabitants sufficient room for exercise and freedom of movement and therefore constitute an inhumane environment for them to live out their lives. Two of the macaws are on drugs because of the stress they must endure from the cramped quarters. Finally, the Applicant's guests note and frequently comment on the cramped quarters in which these birds must live. Consequently, the Applicant's mission to provide both and aesthetic and educational facility is compromised. Additionally, the Garden serves as a significant asset to Hawaii's visitor industry and, as a result, has the obligation to provide the finest possible visitor experience.

3. ALTERNATIVES CONSIDERED

The alternatives to the proposed action would include a no-action alternative, siting the proposed aviary in a different location, removing the macaws as a part of the Garden's exhibits, relocation of the entire Garden facility or closure of the Garden.

3.1 No-Action Alternative.

The no-action alternative would allow for continued use of the Onomea Shoreline Access Trails and continued utilization of existing improvements and facilities within the Project Area, without improving conditions for the resident macaws or increasing educational value of the exhibit.

The benefit of this alternative would be the economic savings involved in providing no improvements for the Garden.

The detrimental aspects of the no-action alternative include continued deterioration of the existing, permitted aviaries that will allow for eventual escape of these birds to invade neighboring agricultural and floricultural croplands; continued containment of the macaws in unsatisfactorily cramped conditions; and continued diminishment of the potential educational value of the exhibit.

The no-action alternative would not serve the public interest, would reduce economic contribution to the local community and would continue the current unsatisfactory housing conditions for the macaws.

3.2 Alternative Siting

The Applicant has considered other siting areas within the Project Area; however, this alternative is not viable due to the lack of suitably flat topography.

3.3 Removal of the Exhibit

The Applicant has considered demolition of the exhibit and removal of the macaws from the Garden.

Removal of the exhibit would free up valuable staff time for other necessary work and would relieve a financial burden involved in maintaining the macaws in good health as well as maintaining the exhibit in excellent condition.

The Applicant has found this alternative unacceptable despite the noted benefits as the exhibit is considered too valuable to the visitor experience of the facility and, as a result, the Applicant proposes to improve the exhibit rather than remove it.

3.4 Relocation of the Garden

The alternative of relocating the Garden would involve moving the existing botanical garden to a different location. The benefit of this alternative would be to retain Onomea Bay in an undeveloped condition to serve no other use. The detriment of this alternative would involve the difficulty, extreme expense and the time in relocating the existing Garden improvements, as well as the loss of the aesthetic beauty to Onomea by relocation to another area. The alternative is also not viable because of the uniqueness of the Garden to its specific location.

3.5 Closure of the Garden

Closure of the Garden would allow for the return of the valley at Onomea to an untended condition. The advantage of this alternative would be that there would be no intrusion into the environmental resources of the area other than those who would enter unlawfully due to the property lying vacant and untended. The detriments of this alternative would be substantial. This would include the significant economic loss of a prime visitor attraction, the loss of the aesthetic value of the Garden, and the loss to the community of the educational resources of this facility. The closure of the Garden would also mean the end to the management and removal of the noxious plant species in this area. The Applicant is vigorously fighting the intrusion of the noxious Miconia within the Project Area. Miconia is a plant which is threatening the entire Onomea area. Without continued maintenance by the Applicant, the Project Area will become invaded by Miconia, choking out all other plant species.

3.6 Alternative Analysis Conclusion

The only feasible alternative by which the Applicant can realistically develop the Applicant's property is by means of the proposed action.

4. THE AFFECTED ENVIRONMENT, POTENTIAL IMPACTS AND MITIGATION MEASURES

4.1 Physical Environment

4.1.1 Location

The Project Area is located at Alakahi, Kahalii and Onomea, South Hilo District, Island of Hawaii and is designated by TMK: (3)2-7-9:02, 06, 10 and 2-7-10:22. (See Location Map, Figure 1).

4.1.2 Surrounding Land Uses

The Project Area is bounded on the south and west by the Old Mamalahoa Highway, on the east by Onomea Bay and the Pacific Ocean, and on the north by an agricultural parcel presently owned by Dan and Pauline Lutkenhouse.

4.1.3 Climate

The tropical coastal climate of the South Hilo District shoreline and Onomea Bay is primarily influenced by northeasterly trade winds and an average of 125 to 150 inches of rainfall annually. The mean annual temperature is approximately 75 degrees Fahrenheit.

4.1.4 Topography, Physiography and Geography

The Project Area, totaling approximately 43 acres, slopes down to the ocean shoreline where it is bordered by steep cliffs. The elevations range from 330 feet along the mauka boundary at the old sugar railroad track, to 200 feet at the Old Mamalahoa Highway, down to 20 feet at the shoreline cliffs. Three streams run through the Project Area: Alakahi Stream, Kahalii Stream (an intermittent stream) and Onomea Stream.

The portion of the Project Area where the new aviary is proposed is relatively flat and at an elevation of approximately 30 feet.

The soils on the Project Site are classified by the U.S. Department of Agriculture Soil Conservation Service as "RB" or "Rough Broken," with very steep slopes ranging from 35 to 70%. This classification is actually a miscellaneous land type referring to steeper precipitous land that is broken by intermittent drainage channels. The depth of this soil type typically ranges from shallow to deep and the presence of numerous rock outcrops suggest these characteristics.

The Land Study Bureau classifies the soil within the Project Area as "E" or "Very Poorly Suited" to agricultural productivity, and the State Department of Agriculture's Land of Importance to the State of Hawaii (ALISH), which lists all of the land in Hawaii with agricultural significance, does not classify the area as being either "Prime" or "Unique Agricultural Land."

Probable Impact: The potential for soil erosion which may occur during construction is minimal because the site is already cleared, for the most part, for the existing aviaries that are to be replaced. The small amount of additional clearing that will be necessary will be done without the use of any heavy equipment so that any consequential erosion will be minimal. In addition, site work will be scheduled only during periods of minimal rainfall and areas that are denuded of vegetation will be replanted or covered as quickly as possible to control erosion. With the application of these practices, it is not anticipated that there will be any substantial adverse impact from soil erosion as a result of the Project.

4.1.5 Natural Hazards

The Project Area is not included on the United States Corps of Engineers Flood Insurance Rate Map ("FIRM"). In addition, the County of Hawaii Department of Public Works records indicate that there are no known drainage problems within the Project Area, despite the fact that Onomea and Alakahi Streams continually flow through the Site.

The U.S. Geological Survey Tsunami Inundation Map depicts the 100-year tsunami inundation line as extending inland at variable distances to the 20 to 30 foot elevation.

The Property is within Lava Hazard Flow Zone 8 on the U.S. Department of Interior Geological Survey Map. The Geological Survey Map provides nine zones, with Zone 1 being the zone with the highest risk of lava inundation and Zone 9 being the zone with least risk of such inundation. Zone 8 areas include the lower slopes of Mauna Kea, with most of the area unaffected by lava flows for the past 10,000 years.

Probable Impact: The proposed improvements within the Project Area, except for possible future landscaping and footpaths, are located a sufficient distance inland from the shoreline. In addition, the vertical basaltic cliffs are believed to provide significant natural protection from occasional storm waves and tsunami-generated waves. Based on this fact, it is anticipated that there will be no adverse impact upon the Project from the threat of tsunamis. Further, because of the location of the Project Area, there is no adverse impact anticipated on the Project from the threat of volcanic inundation.

4.2 Streams

There are three streams that transect the Project Area: the Onomea Stream and the Alakahi Stream, which are perennial streams, and the Kahalii Stream, which may either be an intermittent stream or no longer a stream as defined by the Commission on Water Resources Management, because of a landslide which diverted this stream in 1949.[2]

The Alakahi and Onomea Streams were identified in *Hawaii Stream Assessment, A Preliminary Appraisal of Hawaii Stream Resources*, State of Hawaii, Commission on Water Resource Management and National Park Service, Rivers and Trails Conservation Assistance Program, December 1990, Report R8-4. This report was mandated by the 1988 State legislature to identify streams appropriate for protection. Relevant portions of this report are attached as Exhibit 6.

The report includes a resource inventory and assessment which measured the aquatic resources, riparian resources, cultural resources and recreational resources of streams throughout the State. The Onomea Stream was not included in the aquatic resources inventory; however, the aquatic resources within Alakahi Stream were determined to be "substantial," under the six category ranking system, which ranks streams as outstanding, substantial, moderate, limited, without or unknown. (*Id.* at 134, 155). The "substantial" ranking requires a stream to have at least three representatives from the eleven native aquatic species found in streams. These representatives could either be in the group 1 category containing the four rarest species or the group 2 category containing the remaining species. The "substantial" ranking also requires that a stream contain one or fewer introduced species (*Id.* at 138).

The riparian resources inventory in this study identified no rare, threatened or endangered plant species, protected areas, wetlands or native forests associated with either Onomea or Alakahi Streams. (*Id.* at 190). However, the inventory did note that the presence of feral pigs were detrimental to the streams (*Id.*).

The recreational resources inventory in this study ranked Onomea and Alakahi Streams each as a substantial regional resource, under a five category ranking system of outstanding, substantial, moderate, limited and potential. Both of these streams were designated as providing hiking, fishing, swimming, parks, hunting and scenic views recreational opportunities. (*Id.* at 255).

A stream assessment of the Alakahi and Onomea Streams was conducted by the DLNR Division of Aquatic Resources on March 6, 1996. (See Stream Survey: Alakahi and Onomea Streams, Hawaii Island, Exhibit 7). The native species found in Alakahi Stream included the aholehole (*Kuhlia sandwicensis*), a nearshore estuarine species; the lower elevation native gobies, the o'opu akupa (*Eleotris sandwicensis*) and the o'opu

[2] Per conversation with Donn W. Carlsmith, a former owner and resident of Onomea, during a winter storm in 1949, the northern bank of Kahalii Stream, mauka of the Old Mamalahoa Highway, collapsed, permitting the Kahalii Stream water to cascade down the face of a quarry abutting the stream and eventually reach Onomea Stream, mauka of the Old Mamalahoa Highway. According to Carlsmith, the Kahalii Stream makai of the highway has not flowed since 1949, except for localized runoff during storm conditions.

naniha (*Stenogobius genivittatus*); a mid-level goby, the o'opu nakea (*Awaous stamineus*), which appeared to be abundant in the quadrat sample taken; and the upper-level goby, o'opu nopili (*Sicyopterus stimpsoni*). However, the most common species found in Alakahi Stream was the introduced Tahitian prawn (*Macrobrachium lar*), which was present in about 86% of the sample quadrats. The native species found in Onomea Stream included the aholehole, o'opu nakea, and o'opu nopili with the o'opu nopili being observed in 45% of the stream samples. The Tahitian prawn was not as abundant in Onomea Stream, occurring in only 40% of the sample quadrat.

The 1996 stream assessment concluded that all of the native gobies were present in the Alakahi and Onomea Streams, except for the o'opu alamo'o (*Lentipes concolor*), which commonly occurs in higher elevations in streams without a terminal waterfall, such as the waterfalls within Alakahi and Onomea.

During 1997, another study of Onomea and Alakahi Streams was conducted by personnel associated with the Hawaii Stream Research Center (HSRC) of the University of Hawaii. This study was carried out in response to concerns raised by the U.S. Fish and Wildlife Service (USFWS) and the State Division of Aquatic Resources (DAR) about the impacts of two unpermitted diversions on Onomea and Alakahi Streams, installed by the Applicant in 1979 and 1989 respectively. Removal of these two dams was required by the Hawaii Board of Land and Natural Resources in early September 1997. Additional issues included the impact on streams of the Applicant's planned expansion in the area and their proposed future water withdrawals from Onomea and Alakahi Streams. (See Exhibit 8).

The purpose of this study was to assist the Applicant, as well as State and Federal agencies, in developing responsible long-term stream and watershed management plans for lower Onomea and Alakahi Streams by (1) collecting baseline data on stream biological quality (as evaluated by metrics including fish, invertebrate, and algal abundancies and composition); (2) establishing a stream monitoring program to provide a basis for evaluating variation in functional processes within and between streams over time. The intent was to work within management guideline requirements imposed by the government agencies to provide needed scientific data and to assist the Applicant during the study period to comply with required stream protection and environmental mitigation efforts.

The year-long study was conducted to evaluate physical, chemical and biological parameters in Onomea Stream and Alakahi Stream in South Hilo, Hawaii. While both Onomea Stream and Alakahi Stream are small by Hawaii standards, Onomea Stream had a much larger average discharge (4.55 cfs) during the study than Alakahi Stream (0.36 cfs), and tended to flood more frequently. Both streams had quite low densities of native gobies, crustaceans and snails, and high densities of introduced prawns. A mark and recapture study showed there to be approximately 650 adult prawns in the lowest reach of Onomea Stream and approximately 430 adult prawns in the lowest reach of Alakahi Stream. Likewise, in the reach above the diversion, prawn accounted for all but a few of the individuals recorded during the surveys. Follow-up surveys may indicate whether

removal of the diversions resulted in additional upstream colonization by the native stream macrofauna.

The study found that Onomea and Alakahi Streams both contain the entire compliment of native stream macrofauna, although at quite low densities, indicating potential for the establishment of robust populations of native species in these streams. Interestingly, while *Awaous guamensis* were the most abundant post-larval gobies collected returning to the stream, *Sicyopterus stimsoni* were more abundant as adults. Further investigation into recruitment dynamics (return of larvae to the stream from the ocean) and potential impacts of the aggressive introduced Tahitian prawn on the native species could provide valuable information as to the population dynamics and community structure in the two streams.

There is no known data available for Kahalii Stream regarding any possible stream biota within this stream bed.

No wastewater is presently diverted into Onomea, Kahalii or Alakahi Streams; nor is any water proposed to be diverted into these streams by reason of the proposed Project. The Lily Pond originally was flushed with fresh water on a daily basis, and the overflow from this pond drained out, eventually reaching Alakahi Stream. In April, 1996, the Lily Pond was converted into a self sustaining environment, so that water is not added to this pond; nor, is the pond being drained. The irrigation and drain pipes have, however, been left in place for emergency purposes.

Probable Impact: The recent stream assessments of Onomea and Alakahi Streams have determined that all anticipated native aquatic species were present in these streams prior to removal of the two diversion dams and that all anticipated native aquatic species remain present after removal of the dams. No wastewater from the Project area is or will be diverted into the streams. Therefore, no negative impact is anticipated.

4.2.1 *OEQC's comment letter to the Draft EA, dated May 23, 2005:*

OEQC offered comments for the applicant's consideration and response regarding ***Riparian Resources****. OEQC requested the inclusion of a topographical map showing the relation of the proposed aviary to the streams and coastline in order to analyze potential impact from runoff. The original comment letter from the OEQC* *follows on page 15.*

LINDA LINGLE
GOVERNOR OF HAWAI'I

GENEVIEVE K. Y. SALMONSON
DIRECTOR OF OEQC

STATE OF HAWAI'I
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
DEPARTMENT OF HEALTH
LEOPAPA A KAMEHAMEHA
235 SOUTH BERETANIA STREET, SUITE 702
HONOLULU, HAWAI'I 96813
TELEPHONE (808) 586-4185

In reply, please refer to
File:

May 23, 2005

Mr. Scott A. Lucas
Hawaii Tropical Botanical Garden
P.O. Box 80
Papaikou, Hawai'i 96746

Mr. Samuel J. Lemmo
Office of Conservation and Coastal Lands
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawai'i 96809

Dear Messrs. Lucas and Lemmo:

The Office of Environmental Quality Control has reviewed your draft environmental assessment for the New Aviary at Hawai'i Tropical Botanical Garden, Tax Map Key No. 4th 4-2-22: 15, situated at Onomea Bay, in the judicial district of South Hilo, and offers the following comments for your consideration and response.

1. ***Riparian Resources***: Please include in the environmental assessment a topographical map showing the relation of the proposed aviary in relation to the streams and the coastline. This is necessary in order to analyze possible riparian and coastal impacts from runoff.
2. ***Cultural Impact Assessment and Sustainable Building Guidelines***: Please refer to cultural impact assessment guidance contained on our Internet website (*infra*). Also, please refer to the guidance on sustainable building contained in our Guidebook on the Internet at http://www.state.hi.us/health/oeqc/index.html.

Thank you for the opportunity to comment. If there are any questions, please call Mr. Leslie Segundo, Environmental Health Specialist, at (808) 586-4185.

Sincerely,

Genevieve Salmon

GENEVIEVE SALMONSON
Director

4.2.2 *Applicants response to OEQC's comment letter:*

The applicant, Hawaii Tropical Botanical Garden (HTBG), responded to the OEQC's comments in the response letter dated May 27, shown below, and provided a topographical map (page17) showing the relation of the proposed aviary to the streams and the coastline.

Hawaii Tropical Botanical Garden
A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781 ~ Web Site: www.htbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 ~ E:Mail: htbg@ilhawaii.net

May 27, 2005

Genevieve Salmonson
State of Hawaii-OEQC Department of Health
235 South Bertenia Street, Suite 702
Honolulu, Hawaii 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Botanical Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-010:022

Dear Ms. Salmonson,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropical Botanical Garden's amendment to Conservation Use Permit HA-1447A, application HA-3222 for new Aviary. This letter addresses comments contained in your letter dated May 23, 2005.

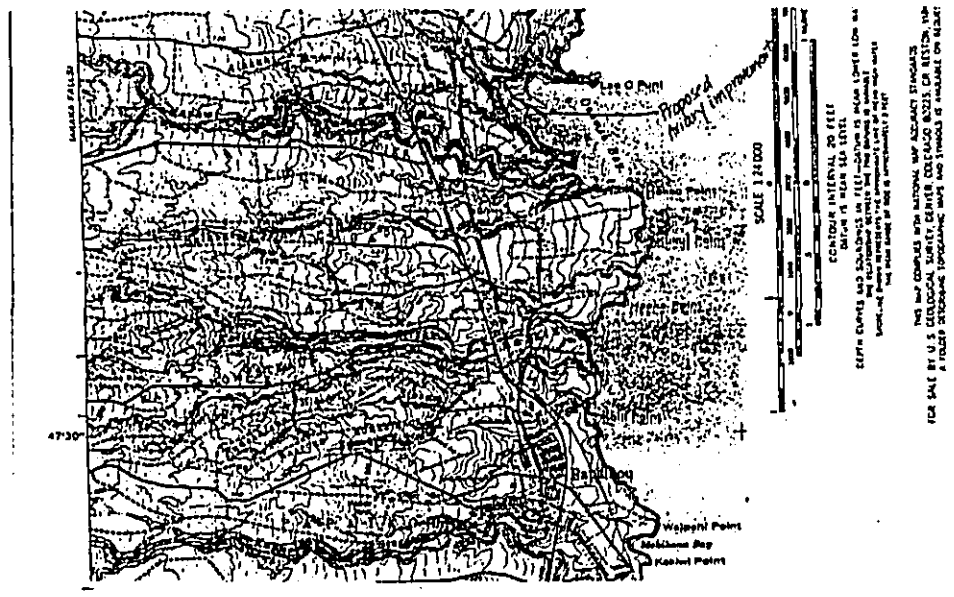
The Draft and Final Environmental Assessment(s), Exhibits 7 & 10 and the two maps accompanying this response show the relation of the proposed Aviary to the streams and the coastline. Currently, the three smaller enclosures which house Hawaii Tropical Botanical Garden's (HTBG) six Macaws are in the exact same location of the proposed improved Aviary. There is no runoff from the current enclosures nor will there be any runoff from the improvement into either stream or the ocean.

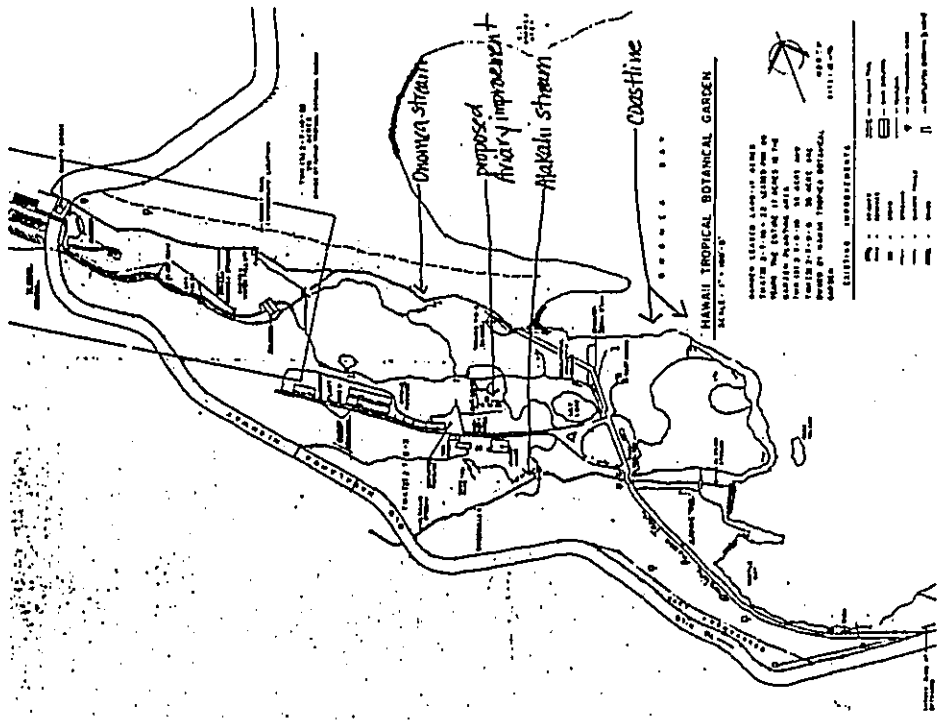
HTBG referred to recommended websites, cultural impact assessment guidance and guidance on sustainable building. We would like to thank you for the recommended resource and we will refer to the sites as needed.

We appreciate your comments on HTBG's draft environmental assessment. Your letter and this response will be appended to the final environmental assessment to ensure a document that adequately addresses pertinent issues.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN
Kate Logan
Manager, Administration and Education





4.3 Flora

Vegetation throughout the improved portion of the Garden includes a collection of approximately 10,000 cultivated plants and trees that represent some 2,000 species,

which are primarily exotic. Controlled cultivation of the exotic species has prevented any from spreading outside the Project Area or becoming a noxious weed.

Vegetation throughout the unimproved portion of the Project Area includes warabi (*Athyrium esculentum*), guava (*Psidium guajava*), African tulip (*Spathodea campanulata*) banyan (*Ficus* spp.), mountain apple (*Syzygium malaccense*), Alexandra palm (*Archontophoenix alexandrae*), bamboo (various), pothos (*Epipremnum aureum*), banana (*Musa* sp.), trumpet tree (*Cecropia peltata*), mango (*Mangifera indica*), strawberry guava (*Psidium cattleianum*), avocado (*Persea americana*), miconia (*Miconia calvescens*), pagoda tree (*Alstonia macrophylla*), octopus tree (*Brassaia actinophylla*), and laua'e fern (*Polypodium scolopendria*). None of these species are endangered or threatened.

Miconia is considered a noxious weed. Since May 21, 1993, the Applicant has been engaged in aggressive eradication of miconia from the project area. However, complete eradication has not been possible because of the substantial infestation on neighboring mauka lands.

Probable Impact: The proposed Project will not have any adverse impact on threatened or endangered plant species, since there are no such species within the Project Area. In addition, the minimal land clearing involved in the proposed Project will not have any significant adverse impact on the plant species of the area. Although there is the possibility that an introduced exotic plant species may grow out of control and become a noxious weed, that possibility is extremely remote in light of the fact that the Applicant has already operated its Garden for 26 years without this type of problem occurring.

4.4 Fauna

Known mammals in the area include the mongoose, the rat and the house mouse. Also, stray dogs and cats are known to roam the area. Although feral pigs are known to contaminate the streams that run through the Project area, these animals are typically found at higher elevations and are only rarely found in the vicinity. The Hawaiian endemic and endangered Hoary Bat (*Lasiurus cinereus semotus*) has been observed in the area. This species forages on insects and roosts solitarily in trees and occasionally lava tubes. Birds in the area are common exotic species.

Within the improved portion of the Garden, there are several caged South American macaws (*Ara macao*). Several carp (Koi) have been introduced in the Lily Pond for mosquito abatement, beauty and general enhancement of the aquatic environment of the Garden.

The Orangeblack Hawaiian Damselfly (*Megalagrion xanthomelas*), a lowland insect species, which is becoming increasingly rare in the State of Hawaii, populates Onomea Stream where it runs through the Applicant's property above the Old Mamalahoa Highway and along Alakahi Stream, also above the Old Mamalahoa

Highway. The species is also found in the vicinity of the Lily Pond in the Garden since fresh water has stopped flowing through the pond. A study conducted for the Bishop Museum in 1995 discusses the habitat for this species in each of the particular locations. (See "The Orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas* (Odonata: Coenagrionidae): Clarifying the Current Range of a Threatened Species," Dan A. Polhemus, *Records of the Hawaiian Biological Survey for 1995,* Exhibit 9).

The species is known to occupy a wide range of habitats and has broad ecological tolerances. Although it appears to be widespread on the Big Island, it has been extirpated from the Islands of Kauai and Maui and is perilously close to extirpation on Oahu. It is believed that the loss of this species is linked more to the introduction of alien aquatic biota than to outright habitat alteration or destruction. (*Id.* at 48).

At the request of the Applicant, David Foote, Acting Station Leader, Hawaii National Park Field Station, Pacific Islands Science Center, performed a study on population dynamics of the Orangeblack Damselfly in the Garden vicinity. As a result, Dr. Foote informed the Applicant that the orangeblack damselfly is widely distributed on the Island of Hawaii, with known populations along all major coastlines, except the Kohalas. The Onomea site represents part of a metapopulation that extends from Keaukaha north to at least Kawainui Stream on the Hamakua Coast. In the vicinity of the Project site, this species has only been collected at Onomea and Alakahi streams, mauka of the Old Mamalahoa Highway, and at Kawainui Stream, makai of the Old Mamalahoa Highway. The orangeblack damselfly was first collected in this area at Onomea Stream on December 15th, 1991. The collection site was just off the bridge on the highway. On June 8th, 1995, this site was revisited and the damselfly was present along the bulldozed clearing at the site of what is now the Applicant's visitor center and further up the stream. The Orangeblack Damselfly has not been observed along either Alakahi or Onomea Streams where they flow through the Project Site makai of the Old Mamalahoa Highway.

Over recent years, the Project Site has become infested with the Coqui Frog (*Eleutherdactylus coqui*). While numerous attempts have been made toward complete eradication through the use of citric acid and following the recommended protocol in its application, success in this endeavor has proven elusive. Nevertheless, the Applicant is continuing in efforts to rid the property of this pest.

Probable Impact: The proposed construction of a new aviary that will occupy essentially the same space as the existing three aviaries is not anticipated to have any adverse effects on the native bird and animal populations. No adverse impacts are expected on populations of the Orangeblack Damselfly since populations presently occur outside of the Project Area.

4.5 Historical/Archaeological Resources

At the request of the Applicant, a field survey was conducted on January 14th, 2004 by Paul H. Rosendahl, Ph.D., Inc. As a result Dr. Rosendahl submitted PHRI

Report 2381-021804, A Historic Properties Assessment Survey for the New Aviary Project, located in Onomea, South Hilo District (attached as Exhibit 10). The Report determined that "no significant archaeological or other cultural remains were found within the New Aviary project area. The only cultural materials identified were several ceramic fragments, and these were in a probable secondary context." Furthermore: "The detrimental effects of construction within the New Aviary project area has been mitigated by the pedestrian survey and STP excavation program. No further archaeological work is recommended in the project area, and it is recommended that an SHPD determination of "no historic properties affected" be granted (in accordance with the general guidance provided by Chapter 284: Section 5[b] of the SHPD Rules HAR Title 13, DLNR; Subtitle 13).

Dr. Rosendahl's Report was submitted to the DLNR Historic Preservation Division and on February 26, 2004 P. Holly McEldowney, Administrator, State Historic Preservation Division advised in a letter to Dr. Rosendahl (attached as Exhibit 11): "We agree with your determination that 'no historic properties will be affected' in the project area."

Probable Impact: Based upon the archaeological field inspections, there are no known archaeological sites within the Project Area that will be affected by the improvements proposed by the project.

4.5.1 OHA's comment letter to the Draft EA, dated May 2, 2005:

The Office of Hawaiian Affairs(OHA) offered comments on the Draft EA regarding the disturbance of subsurface historical deposits and the condition and stewardship of both Onomea and Alakahai streams. The comment letter from OHA follows on pages 21 and 22.

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OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

FAX (808) 594-1865

HRD05/1811

May 02, 2005

Samuel J. Lemmo
Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Post Office Box 621
Honolulu, HI 96809

RE: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A for New Aviary at Hawaii Tropical Botanical Gardens, Pāpa'ikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002, 006, 101, (3) 2-7-010:022

Dear Mr. Lemmo,

The Office of Hawaiian Affairs (OHA) is in receipt of your April 14, 2005, request for comments on the above project, TMK: (3) 2-7-009:002, 006, 101, (3) 2-7-010:022. OHA offers the following comments.

Due of the extent of archaeological efforts, including subsurface exploration, within the proposed project area, further surveys are not warranted. Although construction activities will be completed without the use of heavy machinery, there is a possibly of encountering subsurface cultural deposits, including human burials related to the pre-contact village of Kahali'i. It is known that an historic cemetery, not within the bounds of proposed construction, is located within the Hawaii Tropical Botanical Garden (HTBG) lands. Limited debutage related to tool manufacture and the remains of soil retaining terraces have been located in previous archaeological studies and are testament to the depositional history of what is now part of the HTBG. Because excavations associated with the project are likely to disturb existing subsurface deposits, OHA recommends that all ground altering activities be monitored by a professional archaeologist.

It does not appear that a Cultural Impact Statement has been completed in support of the proposed HTBG expansion project. Information gathered through the Cultural Impact Statement process is crucial in understanding the context of potential cultural material finds. The

process is also necessary in understanding the nature and extent of Native Hawaiian land use during various stages of native and foreign land tenure.

The condition and stewardship of Onomea and Alakahi streams is of some concern for OHA. The past "unpermitted diversions" of both streams by HTBG have required intervention and treatment by the US Fish and Wildlife Service and the Hawaii State Division of Aquatic Resources. Land and water use in a conservation district is regulated to uphold the integrity of Hawaii's resources. OHA trusts that in the future all precautions will be taken to protect and preserve the Onomea and Alakahi Streams, which are the fragile host to a variety of indigenous and endemic wildlife species.

OHA further requests your assurances that if the project goes forward, should iwi or Native Hawaiian cultural or traditional deposits be found during ground disturbance, work will cease, and the appropriate agencies will be contacted pursuant to applicable law.

Thank you for the opportunity to comment. If you have further questions or concerns, please contact Jesse Yorck at 594-1962 or jessey@oha.org.

'O wau iho nō,

Clyde W. Nāmu'o
Administrator

4.5.2 *Applicants response to OHA's comment letter:*

The applicant, Hawaii Tropical Botanical Garden (HTBG), responded to OHA's comments in the response letter dated May 27, 2005, shown below and on page 24.

Hawaii Tropical Botanical Garden

A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781 – Web Site: www.htbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 – E:Mail: htbg@ilhawaii.net

May 27, 2005

Clyde W. Nāmu'o, Administrator
State of Hawaii-Office of Hawaiian Affairs
711 Kapi'olani Boulevard, Suite 500
Honolulu, Hawai'i 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Botanical Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-010:022

Dear Mr. Nāmu'o,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropical Botanical Garden's amendment to Conservation Use Permit HA-1447A, application HA-3222 for new Aviary. This letter addresses comments contained in your letter dated May 2, 2005.

Hawaii Tropical Botanical Garden (HTBG) understands your concerns regarding subsurface cultural deposits related to the pre-contact village of Kahali'i. The proposed new Aviary requires no subsurface construction. The only "groundwork" required for the proposed Aviary is the placement of several 1'wide by 1' deep footings. Your recommendation to have all ground altering activities monitored is noted.

Presently HTBG's six Macaws are housed in three separate enclosures. The draft environmental assessment outlines an improvement to an existing structure, rather than a new construction project. The proposal requests permission to erect one enclosure, in the same exact location, which would allow our six Macaws to live in one unit rather than three separate smaller ones.

HTBG is a non-profit educational institution that respects and understands the queries raised in your response letter. The history and cultural significance of Onomea Valley are protected and perpetuated by the staff and policies of the Garden today.

We appreciate your comments on HTBG's draft environmental assessment. Your letter and this response will also be appended to the final environmental assessment to ensure a document that adequately addresses pertinent issues.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN

Kate Logan
Manager, Administration and Education

4.6 Air Quality

The northeast trade wind pattern on the windward coast, in which the Project Area is located, is characterized by minor and localized up slope and down slope breezes from Mauna Kea. This wind pattern minimized the potential for dusty conditions to develop in the area.

Probable Impact: Site clearing and construction will be conducted by hand, with no heavy equipment utilized. Because of the damp climate of the Project Area, it is not anticipated that dust will be emitted as a result of construction activities. In addition, the aviary structure will be prefabricated on the mainland. The only construction activities involved in the project will be assembly of the prefabricated parts. Therefore, the Proposed Project is not anticipated to create any substantial adverse impact on the air quality of the area.

4.7 **Noise Quality**

The noise generated in the vicinity of the Project Area comes from the existing traffic along the Old Mamalahoa Highway and from low flying aircraft in the area. Other noise in the Project Area comes from natural sources, such as the ocean, wind and wildlife.

Probable Impact: Site clearing and construction of the trails and related improvements will be accomplished by hand, without the use of heavy equipment. Some minor short-term increase in noise level may be experienced during assembly of the Aviary. However, this noise will be confined to normal daylight hours. Since there are

no neighbors residing in the vicinity of the Project Area, there is no substantial adverse impact upon the noise quality anticipated by the construction activities.

4.8 Visual Attributes

The present landscape of the Project Area contains the three existing aviaries and a selection of cultivated exotic plants to enhance the visual appeal. There is also an asphalt paved footpath to provide visitors access to the aviaries. The Applicant believes that removal of the existing small, aging, wood frame aviaries and replacement with a single large permanent, professionally-designed structure, with complimentary landscaping within and without the structure, will greatly enhance the visual appeal of the display.

Probable Impact: The Proposed Action is anticipated to change the visual attributes of the Project Area from a rather dilapidated, 12 year old display into a world-class aviary that is surrounded, within and without, by integrated and complimentary landscaping that will provide significantly enhanced living conditions for the macaws as well as a beautiful and greatly enhanced educational resource for visitors. This, the Proposed Action will enhance the visual attributes of the Project Area.

4.9 Socioeconomic Considerations

The Garden is a major visitor attraction in the South Hilo area, with an average 200 guests visiting each day. Nearly 50% of the Garden's nearly 3,000 Members are residents of the Big Island and comprise a significant sector of daily visitation. It contains a world-class display of more than 10,000 tropical plants, representing more than 2,000 species and provides over $2,000,000 in revenue annually to the local economy. The Proposed Action will only serve to enhance this valuable attraction and educational facility.

4.10 Public Facilities and Services

4.10.1 Transportation Facilities/Traffic

Present access to the Project Area is provided from the Old Mamalahoa Highway, a County owned and maintained road, which has a 17-foot wide paved roadway surface in a designated 30-foot wide right-of-way. The Applicant's visitor center provides a large parking lot for the use of its patrons. The Garden Gate, entrance to the Garden proper, lies across the highway from the visitor center. Under agreement with the County of Hawaii, the Applicant maintains, free from obstruction, the sight distance as required by County law.

Probable Impact: The Proposed Action will have no impact on existing transportation facilities or highway traffic.

4.10.2 Water

There is no water from the County of Hawaii municipal water system available to the Project Area. The Applicant obtains water for irrigation and restroom facilities from a diversion located in Onomea Stream, upstream of the Applicant's visitor center, as permitted by CDUP HA-1447A. It is estimated that water usage for existing improvements is approximately 398,000 gallons per year, or approximately 1,090 gpd. There is no potable water available to the Project Area.

The Proposed Action will not require any increase in water usage.

Probable Impact: Since there will be no increase in water usage by the Proposed Action, no impact is anticipated.

4.10.3 Wastewater Treatment and Disposal

The Proposed Action is merely a reconfiguration and improvement upon the existing exhibit, which generates no wastewater. Effluent from the macaws is minimal and is absorbed as nutrients by the surrounding vegetation.

Probable Impact: There is no substantial adverse impact anticipated to the streams, the groundwater or the near shore waters by reason of the Proposed Action.

4.10.4 Utilities

Public utilities, including overhead electricity and telephone, are available to the Project Area; although not specifically to the Aviary Site under consideration. Cellular telephone service is available to the Project Area, including the Aviary Site.

Probable Impact: Since neither electrical nor telephone services are required for the Project, there is no anticipated adverse impact upon electrical and telephone utility service by reason of the Proposed Action.

4.10.5 Police and Fire Protection and Emergency Services

Police and fire protection services are provided from the Hilo police station and Central fire station, approximately eight miles south of the Project Area. Advanced life support ambulance units are located in Hilo. Hilo Medical Center also houses a basic life support unit.

Probable Impact: The Proposed Action is not anticipated to increase the demand for police, fire or emergency services. Therefore, no anticipated adverse impact is anticipated.

5 RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA

5.4 State Land Use Law

All lands with the State have been classified into one of four land use districts: urban, rural, agricultural and conservation, by the State Land Use Commission, pursuant to Chapter 205, HRS. The Project Area lies within the State land use conservation district.

Section 205-2, HRS defines the conservation district as:

> Areas necessary for protecting watersheds and water sources; preserving scenic and historic areas; providing park lands, wilderness, and beach reserves; *conserving endemic plants, fish and wildlife*; preventing floods and soil erosion; forestry; open space areas whose existing openness, natural condition, or present state of use, if retained, would enhance the present or potential value of abutting or surrounding communities or would maintain or enhance the conservation of natural or scenic resources; areas of value for recreational purposes; other related activities; and other permitted uses not detrimental to a multiple use conservation concept.

Lands located within State land use conservation districts are administered by DLNR, pursuant to Chapter 183C HRS.

5.5 State Administrative Rules Governing Land Uses within Conservation Districts

Title 13 of the Hawaii Administrative Rules ("HAR"), for the Department of Land and Natural Resources, under Subtitle 1, Chapter 5, regulates land uses within the Conservation District. The rules establish five subzones within the Conservation District: the protective, limited, resource, general and special subzones. All land within the Conservation district has been designated within one of the five subzones by the BLNR.

The Project Area has been designated within the resource or (R) subzone. Section 13-5-13, HAR, provides that the objective of this subzone "is to develop, with proper management, areas to ensure sustained use of the natural resources of those areas." The rule also provides that the (R) subzone encompasses:

> (1) Lands necessary for providing future parkland and land presently used for national, state, county, or private parks;...
> (2) Lands suitable for outdoor recreational uses such as hunting, fishing, hiking, camping and picnicking;..."

Permitted land uses within the (R) subzone, under Section 13-5-24, HAR, include:

- Signs, including safety signs, danger signs, no trespassing signs, and other informational signs (P-8)
- Botanical gardens and private parks under an approved management plan (L-2)

- Landscaping, defined as alteration of plant cover, including trees, and removal of noxious plants for maintenance purposes (L-4), (R-5)
- Construction or placement of structures accessory to any existing structures, building or facility under an existing conservation district use permit (L-7).

The uses proposed by the Project are permitted land uses within the (R) subzone, under the DLNR rules. Essentially the project is an improvement of a existing structures that were previously permitted under CDUP 1447.

5.6 **Hawaii State Plan**

The Hawaii State Plan, Chapter 226, HRS, establishes a set of goals, objectives and policies to serve as long-range guidelines for the growth and development of the State. The following sections from the Hawaii State Plan contain guidelines that are relevant to the Proposed Action:

Section 226-8. Objective and policies for the economy – visitor industry.

Objective: Planning for the State's economy with regard to the visitor industry shall Be directed towards the achievement of the objective of the visitor industry that constitutes a major component of steady growth for Hawaii's economy.

Policies: To support and assist in the promotion of Hawaii's visitor attractions and facilities.

Improve the quality of existing visitor destination areas.

Develop the industry in a manner that will continue to provide job opportunities and steady employment for Hawaii's people.

Foster a recognition of the contribution of the visitor industry to Hawaii's economy and the need to perpetuate the aloha spirit.

Analysis: The economic benefit of the Garden is evident from the employment generated, the number of visitors who visit this facility annually, and the related visitor expenditures into the local economy. The new Aviary is intended to enhance the visitor experience by providing a display that will improve the educational value over that of the existing display as well as improve the overall aesthetics of the Garden.

Section 226-12. Objective and policies for the physical environment – scenic, natural beauty and historic resources.

Objective: Planning for the State's physical environment shall be directed toward achievement of the enhancement of Hawaii's scenic assets, natural beauty, and multi-cultural/historic resources.

Policies: Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, oceans, scenic landscapes and other natural features.

Encourage the design of development and activities that compliment the natural beauty of the Islands.

Analysis: The Proposed Action will preserve the natural beauty of Onomea Valley, will continue to preserve the aesthetic, scientific and educational values of the area, and will improve upon the beauty by replacing the existing dilapidated aviaries with a new state-of-the-art, world-class structure that will blend into the Garden so as to be far less obtrusive than the existing.

Section 226-23. Objective and policies for socio-cultural advancement – leisure.

Objective: Planning for the State's socio-cultural advancement with regard to leisure shall be directed toward the achievement of the adequate provision of resources to accommodate diverse cultural, artistic and recreational needs for present and future generations.

Policy: Promote the recreational and educational potential of natural resources having scenic, open space, cultural, historical, geological or biological values while ensuring that their inherent values are preserved.

Analysis: The Proposed Action will promote the continued scientific and educational values of the Garden. It will also expand on a valuable scenic recreational facility.

5.7 Hawaii County General Plan

The Hawaii County General Plan is a policy document for the long range comprehensive development of all land within the County of Hawaii. The plan contains goals, policies and standards as well as a set of land use maps, designated as the General Plan Land Use Pattern Allocation Guide (LUPAG) maps and showing the locations of desired land uses.

The current LUPAG map designates the Project Area as "Extensive Agriculture." The Extensive Agricultural designation includes pasture and range lands. The more conservation-oriented Garden does not conflict with the Extensive Agriculture designation of the General Plan.

5.8 Hawaii County Zoning

The Project Area is zoned under the Hawaii County Zoning Code (Chapter 25, Hawaii County Code) as Agricultural, with minimum lot size of 20 acres (A-20a). The Proposed Action is permitted under this zoning district.

5.9 Special Management Area

The Project Area is located within the Special Management Area (SMA) as defined by Chapter 205A, HRS, and Rule 9 of the County of Hawaii Planning Commission Rules.

An SMA Use Permit Assessment Application (SMAA 03-08) was submitted to the County of Hawaii Planning Department concerning the Project and in a letter dated July 3, 2003 (Exhibit 1) the determination was made that the Project qualifies for an SMA exemption because the new larger aviary will occupy essentially the same space as the existing three aviaries and the aviary is a mauka location and not within the 40-feet shoreline setback area.

Pursuant to SMA Rule 9-4(10) C, the Planning Director determined that the proposed improvements are exempt from the definition of development. The new Aviary work is exempt under Rule 9-4(10) B (vi) and (x) as repair and maintenance to the existing aviary use. According to Rule 9-10G, the Planning Director declares this request exempt from the SMA rules.

Not a Substantial Adverse Effect. According to the County Department of Public Works (DPW) – Engineering Division, parcel 02 is in flood zone X. Furthermore, the Project does not trigger the substantial adverse effect criteria of SMA Rule 9-10H, 1 through 10.

General Plan (GP) Natural Beauty Criteria & SMA Line of Sight toward the Sea. The GP Support Document at 33 confirms that TMK: 2-7-09: 02, Onomea Bay Area, is a listed site example of natural beauty in the South Hilo District. The GP natural beauty element at 4 – 5 requires protection of scenic vistas and view planes from being obstructed.

In addition, SMA Rule 9-10H.10, and state law SMA guidelines, Haw. Rev. Statu. Sec. 205A-26(3)(D), requires, where reasonable, to minimize any development which would substantially interfere with or detract from the line of sight toward the sea from the State highway nearest the coast. In this case, the Old Mamalahoa Highway and/or the Hawaii Belt Road (Hawaii State Route 19) are the State highways nearest the coast, and to the Project Site.

Haw. Rev. Stat. sec. 205A-26(2)(C) requires a SMA development to be consistent with zoning, and the 17-feet height of the proposed aviary is less than and complies with the 20-feet maximum height permitted of accessory structures in the Zoning Code. The

low height of the aviary and the makai distance of these projects from the nearest coastal state highway are determined to be of a low visual impact. And therefore, the Planning Director finds that this improvement would not substantially interfere with, detract from or obstruct the SMA guideline, the line of sight toward the sea from the nearest State coastal highway or the GP's mauka-makai view-plane course of action.

Waiver: Submission of a Certified Shoreline Survey. Pursuant to Planning Commission SMA Rule 9-10B(8) and Planning Department Rule 11-4(c), the submission of a certified shoreline survey is waived. The Project is setback a considerable mauka distance from the shoreline; and, for the purpose of cited rules, such a setback constitutes a considerable inland distance from the shoreline far exceeding the mandatory minimum 40 feet shoreline setback required by Rule 11.5.

5.10 Environmental Impact Statement

Section 343-5(a)(2), HRS, provides that any use that is proposed within any land classified as conservation district land by the State land use commission under Chapter 205, is subject to the Environmental Impact Statement Law, Chapter 343, HRS.

Section 343-5(c), HRS, provides that applicants proposing actions subject to Chapter 343, HRS

> "...shall prepare an environmental assessment of such proposed action at the earliest practicable time to determine whether an environmental impact statement shall be required."

This environmental assessment has been prepared to fulfill these requirements.

6 DETERMINATION OF SIGNIFICANCE

Based on the analysis presented in this assessment, the Proposed Action will not pose any significant adverse environmental impacts.

List of Exhibits

1. County of Hawaii-Planning Department letter dated July 3, 2003
2. List of Agencies Sent Consultation Letter
3. Example Consultation Letter Sent To Agencies
4. County of Hawaii-Comment letters
5. Proposed Aviary Line Drawings
6. Hawaii Stream Assessment
7. Onomea and Alakahi Stream Survey
8. Onomea and Alakahi Stream Survey Final Report, "Baseline And Monitoring Studies of Onomea and Alakahi Streams, Hamakua Coast, Hawaii"
9. The Orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas* (Odonata: Coenagrionidae): Clarifying the Current Range of Threatened Species, *Records of the Hawaii Biological Survey for 1995*
10. Historic Properties Assessment Survey, New Aviary Project, Hawaii Tropical Botanical Garden: Report 2381-012804
11. Review of PHRI Report 2381-012804
12. Comments Received to the Draft Environmental Assessment and Responses Provided to the Comments

CORRECTION

THE PRECEDING DOCUMENT(S) HAS BEEN REPHOTOGRAPHED TO ASSURE LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

List of Exhibits

1. County of Hawaii-Planning Department letter dated July 3, 2003
2. List of Agencies Sent Consultation Letter
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Harry Kim
Mayor

Christopher J. Yuen
Director

Roy R. Takemoto
Deputy Director

County of Hawaii
PLANNING DEPARTMENT
101 Pauahi Street, Suite 3 • Hilo, Hawaii 96720-3043
(808) 961-8288 • Fax (808) 961-8742

July 3, 2003

Mr. Dan J. Lutkenhouse
President
Hawaii Tropical Botanical Garden
P.O. Box 80
Papaikou, HI 96781

Dear Mr. Lutkenhouse:

Special Management Area (SMA) Use Permit
Assessment Application (SMAA 03-08)

Applicant: Hawaii Tropical Botanical Garden (HTBG)

After-the-Fact Request: Repair & Maintenance to Existing Shoreline Access Trail with Accessory Improvements in the State Land Use Conservation District
Alakahi & Kahalii, S. Hilo, Hawaii Island

TMK: 2-9-06: 02, 06, & 10 and 2-7-10: 22 (HA-1447)

The above SMA assessment application was received for two proposals: for an after-the-fact request of work completed to repair and maintain an existing public access trail to the shoreline; and the second request, a proposal to demolish three existing aviaries. Construction of a single large aviary is proposed to replace the demolished aviaries.

These proposals are in the State Conservation district and the County of Hawaii's SMA zone and both qualify for a SMA exemption. The determinations are discussed below along with the mandatory shoreline setback requirement.

Project Description
Public Access Trail. The completed work paved a 195-linear feet asphalt surface on a portion of the existing 12-feet wide Onomea Access Trail. HTBG improved the segment of the trail that passes through the center of its garden and it is the trail section used by

EXHIBIT 1

their patrons for access between the mauka and makai portions of the garden. Allegedly, HTBG initially maintained this portion of the trail with frequent applications of rock and gravel; however, the asphalt surface reduces the need for recurring labor intensive maintenance and it provides a hard surface for pedestrians and wheelchair access.

According to the submitted site plan, the improved trail segment is a mauka portion of the public access located on parcel 02, a 17+ acre lot. The improved trail segment is located mauka of and is not within the 40-feet shoreline setback.

Macaw Aviary. The new larger aviary will occupy essentially the same space as the existing three aviaries and will house six macaws. According to the site plan, the aviary is also a mauka location and it is not within the 40-feet shoreline setback area. The given structural dimensions are listed below:

- 40-feet length x 20-feet wide
- 17-feet height to peak roof
- The aviary would be permanently footed in a concrete slab with a 12-foot wide curb around the structure.
- 4-inch concrete slab: 64-feet length x 44-feet width.
- Post and beam black galvanized aluminum tube framing with after weaving mesh enclosure panels.

Declaration of Exemption from SMA Rules. Pursuant to SMA Rule 9-4(10) C, the Director has determined that the proposed and accessory improvements, described above, is exempt from the definition of development. The trail segment and the new aviary repair and maintenance work are exempt under Rule 9-4(10) B (vi) and (x) as repair and maintenance to the existing trail and aviary use; in addition, it is an action consistent with the creation of other rights in the land: public or ADA access regarding the trail segment. According to Rule 9-10G, the Planning Director declares this request exempt from the SMA rules.

While further SMA review of this project and related improvements is not required, all other applicable Code requirements must be satisfied. The proposed project has also been determined consistent with the State coastal zone management objectives and policies and the SMA guidelines of Hawaii Revised Statutes Chapter 205A.

SMA Minor Permit No. 5 (March 11, 1994) approved the initial three aviaries for six Macaw birds (8x8x8 foot bird cages). SMA Minor Permit No. 82-028 (July 23, 1982) approved the establishment of the botanical garden, arboretum, and related improvements. SMA Exemption Letter (December 15, 1995) exempted the clearing and fencing of two pedestrian trails on parcel 02, part of mediation agreement (October 27, 1995) and a BLNR approved public access plan.

Not a Substantial Adverse Effect. According to the County Department of Public Works (DPW) – Engineering Division, parcel 02 is in flood zone X. Furthermore, both projects do not trigger the substantial adverse effect criteria of SMA Rule 9-10H. 1 through 10.

General Plan (GP) Natural Beauty Criteria & SMA Line of Sight toward the Sea. The GP Support Document at 33 confirms that TMK: 2-7-09: 02, Onomea Bay Area, is a listed site example of natural beauty in the South Hilo district. The GP natural beauty element at 4 - 5 requires protection of scenic vistas and view planes from becoming obstructed.

In addition, SMA Rule 9-10H.10, and the state law SMA guideline, Haw. Rev. Stat. sec. 205A-26(3)(D), requires, where reasonable, to minimize any development which would substantially interfere with or detract from the line of sight toward the sea from the State highway nearest the coast. In this case, the Old Mamalahoa Highway and/or the Hawaii Belt Road, (Hawaii State Route 19) are the state highways nearest the coast, and to the project site.

Haw. Rev. Stat. sec. 205A-26(2)(C) requires a SMA development to be consistent with zoning, and the 17-feet height of the proposed aviary is less than and complies with the 20-feet maximum height permitted of accessory structures in the Zoning Code. The at-grade pavement improvements to a trail segment, the low height of the aviary, and the makai distance of these projects from the nearest coastal state highway are determined to be a low visual impact. And therefore, we find that these improvements would not substantially interfere with, detract from or obstruct the SMA guideline, the line of sight toward the sea from the nearest State coastal highway or the GP's mauka-makai view-plane course of action.

Waiver: Submission of Certified Shoreline Survey. Pursuant to Planning Commission SMA Rule 9-10B(8) and Planning Department Rule 11-4(c), the submission of a certified shoreline survey is waived. Both projects are setback a considerable mauka distance from the shoreline; and, for the purpose of the cited rules, such a setback constitutes a considerable inland distance from the shoreline far exceeding the mandatory minimum 40 feet shoreline setback required by Rule 11-5.

Please contact staff planner, Earl Lucero, for any questions you may have on this matter. at 961-8288.

Sincerely,

CHRISTOPHER J. YUEN
Planning Director

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cc: Ms. Dierdre S. Mamiya, Administrator
Attention: Mr. Sam Lemmo
State of Hawaii Department of Land & Natural Resources
Land Division
P.O. Box 621
Honolulu, HI 96809

Ms. Patricia Edwards, Investigator
State of Hawaii – DLNR
Division of Conservation & Resources Enforcement
Hearing Officer/Administrative Penalty System
1151 Punchbowl St., Honolulu, HI 96813

LIST OF AGENCIES SENT CONSULTATION LETTER

Hawaii Visitors Bureau – Big Island Chapter
250 Keawe Street
Hilo, HI 96720

Japanese C of C & Industry of Hawaii
Waiakea Villas
400 Hualani Street
Hilo, HI 96720

State of Hawaii
Dept. of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

State of Hawaii
Historic Preservation Division
1151 Punchbowl Street
Honolulu, HI 96813

Ms. Debbie Ward
Sierra Club – Moku Loa
P.O. Box 1137
Hilo, HI 96721

U.S. Dept. of the Interior
Fish and Wildlife Services
P.O. Box 50156
Honolulu, HI 96850

County of Hawaii
Planning Department
101 Pauahi Street, Suite 3
Hilo, HI 96720

County of Hawaii
Dept. of Parks and Recreation
25 Aupuni Street
Hilo, HI 96720

State Division of Water Resources Management
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Aquatic Resources Division
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Destination Hilo
P.O. Box 1391
Hilo, HI 96720

Hawaii Island Chamber of Commerce
22 Kamehameha Avenue
Hilo, HI 96720

County of Hawaii
Office of the Mayor
25 Aupuni Street
Hilo, HI 96720

Na Ala Hele Program
State Division of Forestry & Wildlife
P.O. Box 4849
Hilo, HI 96720

Office of State Planning
250 South Hotel Street, 4th Floor
Honolulu, HI 96813

Paula Helfrich
Hawaii Island Economic Development Board
200 Kanoelehua Ave., PMB 281
Hilo, HI 96720

County of Hawaii
Department of Public Works
101 Pauahi Street, Suite 7
Hilo, HI 96720

Librarian
U.H.H. Library
P.O. Box 1357
Hilo, HI 96720

Editor
Hawaii Tribune Herald
355 Kinoole Street
Hilo, HI 96720

Editor
West Hawaii Today
P.O. Box 789
Kailua-Kona, HI 96740

EXHIBIT 2

September 24, 2003

Dear

RE: HAWAII TROPICAL BOTANICAL GARDEN
Onomea Bay, Hawaii
Environmental Assessment for Proposed Demolition of Three Existing Aviaries and Construction of a New Aviary in their Place

Hawaii Tropical Botanical Garden is in the midst of preparing an environmental assessment that will provide the State Board of Land and Natural Resources with supplemental information to review a related Conservation District Use Application (CDUA) for a project being proposed to demolish three existing small aviaries and replace them with a single, large enclosure.

During preparation of the environmental assessment, Title 11, Chapter 200, of the Hawaii Administrative Rules, requires that applicants should consult with agencies, organizations, citizen groups and individuals having jurisdiction to expertise relating to a proposed project. This letter represents a more formal approach to obtain your concerns and comments prior to completion of the draft environmental assessment.

The three existing aviaries the Garden proposes to demolish were permitted under Conservation District Use Permit No. 1447. Each of them measures eight feet wide by eight feet deep by eight feet high, occupying 192 square feet. They are arranged in an "L" configuration, with separation space between them of eight feet so that they occupy a total area 38 feet long by 20 feet wide, or 760 square feet. The structural integrity of these aviaries has deteriorated over the years and requires attention. In the place of these three aviaries, the Garden is proposing to construct a single aviary constructed of anodized aluminum, measuring 40 feet in length, 20 feet in width (an area of 800 square feet) and 17 feet high. This will provide a professional, permanent and satisfactory facility for housing the Garden's six macaws. Landscaping within the aviary would blend the structure into the surrounding rain forest so that it would be unobtrusive and negligibly noticeable.

With this perspective, we invite you to provide written comments concerning any planning issues or concerns that you have regarding the proposed project. Your input will be reviewed and evaluated by Hawaii Tropical Botanical Garden and its consultants

EXHIBIT 3

during preparation of the environmental assessment. In addition, your written comments will be incorporated into the draft environmental assessment document.

We thank you for your potential participation in the planning of this project. We would appreciate your response by October 15, 2003, in order to insure that your comments are addressed in the draft environmental assessment. Should you have any questions, please contact me at your convenience.

Yours truly,

Scott A. Lucas
Administrator

Harry Kim
Mayor

Christopher J. Yuen
Director

Roy R. Takemoto
Deputy Director

County of Hawaii
PLANNING DEPARTMENT
101 Pauahi Street, Suite 3 • Hilo, Hawaii 96720-3043
(808) 961-8288 • Fax (808) 961-8742

October 13, 2003

Mr. Scott A. Lucas, Administrator
Hawaii Tropical Botanical Garden
P. O. Box 80
Papaikou, HI 96781

Dear Mr. Lucas:

Pre-Consultation on Environmental Assessment
Request: Proposed Demolition of the Three Existing Aviaries and Construction of a New Aviary in their Place
Applicant: Hawaii Tropical Botanical Garden
TMK: 2-7-9:2, Onomea, South Hilo, Hawaii

This is to acknowledge receipt of your September 24, 2003 letter requesting our comments on the proposed demolition of the three 8'x8'x8' aviaries and the construction of a 40 feet in length, 20 feet in width and 17 feet high aviary that would occupy essentially the same space.

We have the following to offer regarding the proposed project:

1. This 17.724 acre parcel is designated Conservation by the State Land Use Commission.

2. The County zoning is Agricultural (A-20a). However, as it is also in the State designated Conservation area, there is no County zoning per se. Therefore, the Department of Land and Natural Resources (DLNR) has jurisdiction on any use, which occurs in this Conservation area.

EXHIBIT 4

3. According to the Land Use Pattern Allocation Guide Map of the General Plan, the parcel is designated Open and Extensive Agricultural. In addition, the General Plan Natural Beauty Element lists the Onomea Bay area as an example of natural beauty.

4. The subject parcel is located in the County's Special Management Area (SMA).

5. Special Management Area Minor Permit No. 5 (SMM 5) was issued on March 11, 1994 for the after-the-fact construction of a rain shelter, and installation of a zoological garden, 3-cage aviary, a Lily Lake and "No Trespassing" signs. A copy of SMM 5 is enclosed for your perusal.

6. The new aviary is exempt from SMA requirements as Rule 9-4(B)(vi) states that *"Repair, maintenance, or interior alterations to existing structures or relating to existing uses."* is not considered development.

We appreciate the opportunity to comment on the proposed project. If you have questions, please feel free to contact Esther Imamura or Larry Brown of our office at 961-8288.

Sincerely,

CHRISTOPHER J. YUEN
Planning Director

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Enclosure

xc: Ms. Dierdre S. Mamiya, Administrator
Department of Land and Natural Resources
Land Division
P. O. Box 621
Honolulu HI 96809

Harry Kim
Mayor

Christopher J. Yuen
Director

Roy R. Takemoto
Deputy Director

County of Hawaii
PLANNING DEPARTMENT
101 Pauahi Street, Suite 3 • Hilo, Hawaii 96720-3043
(808) 961-8288 • Fax (808) 961-8742

July 3, 2003

Mr. Dan J. Lutkenhouse
President
Hawaii Tropical Botanical Garden
P.O. Box 80
Papaikou, HI 96781

Dear Mr. Lutkenhouse:

Special Management Area (SMA) Use Permit Assessment Application (SMAA 03-39)
Applicant: Hawaii Tropical Botanical Garden (HTBG)
After-the-Fact Request: Repair & Maintenance to Existing Shoreline Access Trail with Accessory Improvements in the State Land Use Conservation District
Alakahi & Kahalii, S. Hilo, Hawaii Island
TMK: 2-9-06: 02, 06, & 10 and 2-7-10: 22 (HA-1447)

The above SMA assessment application was received for two proposals: for an after-the-fact request of work completed to repair and maintain an existing public access trail to the shoreline; and the second request, a proposal to demolish three existing aviaries. Construction of a single large aviary is proposed to replace the demolished aviaries.

These proposals are in the State Conservation district and the County of Hawaii's SMA zone and both qualify for a SMA exemption. The determinations are discussed below along with the mandatory shoreline setback requirement.

Project Description

Public Access Trail. The completed work paved a 195-linear feet asphalt surface on a portion of the existing 12-feet wide Onomea Access Trail. HTBG improved the segment of the trail that passes through the center of its garden and it is the trail section used by

their patrons for access between the mauka and makai portions of the garden. Allegedly, HTBG initially maintained this portion of the trail with frequent applications of rock and gravel; however, the asphalt surface reduces the need for recurring labor intensive maintenance and it provides a hard surface for pedestrians and wheelchair access.

According to the submitted site plan, the improved trail segment is a mauka portion of the public access located on parcel 02, a 17+ acre lot. The improved trail segment is located mauka of and is not within the 40-feet shoreline setback.

Macaw Aviary. The new larger aviary will occupy essentially the same space as the existing three aviaries and will house six macaws. According to the site plan, the aviary is also a mauka location and it is not within the 40-feet shoreline setback area. The given structural dimensions are listed below:

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While further SMA review of this project and related improvements is not required, all other applicable Code requirements must be satisfied. The proposed project has also been determined consistent with the State coastal zone management objectives and policies and the SMA guidelines of Hawaii Revised Statutes Chapter 205A.

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General Plan (GP) Natural Beauty Criteria & SMA Line of Sight toward the Sea. The GP Support Document at 33 confirms that TMK: 2-7-09: 02, Onomea Bay Area, is a listed site example of natural beauty in the South Hilo district. The GP natural beauty element at 4 - 5 requires protection of scenic vistas and view planes from becoming obstructed.

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Please contact staff planner, Earl Lucero, for any questions you may have on this matter. at 961-8288.

Sincerely,

CHRISTOPHER J. YUEN
Planning Director

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cc: Ms. Dierdre S. Mamiya, Administrator
Attention: Mr. Sam Lemmo
State of Hawaii Department of Land & Natural Resources
Land Division
P.O. Box 621
Honolulu, HI 96809

Ms. Patricia Edwards, Investigator
State of Hawaii – DLNR
Division of Conservation & Resources Enforcement
Hearing Officer/Administrative Penalty System
1151 Punchbowl St., Honolulu, HI 96813

Harry Kim
Mayor

Dixie Kaetsu
Managing Director

Peter L. Hendricks
Deputy Managing Director

County of Hawai'i

25 Aupuni Street, Room 215 • Hilo, Hawai'i 96720-4252 • (808) 961-8211 • Fax (808) 961-6553
KONA: 75-5706 Kuakini Highway, Suite 103 • Kailua-Kona, Hawai'i 96740
(808) 329-5226 • Fax (808) 326-5663

September 29, 2003

Scott A. Lucas, Administrator
Hawai'i Tropical Botanical Garden
P. O. Box 80
Papaikou, HI 96781

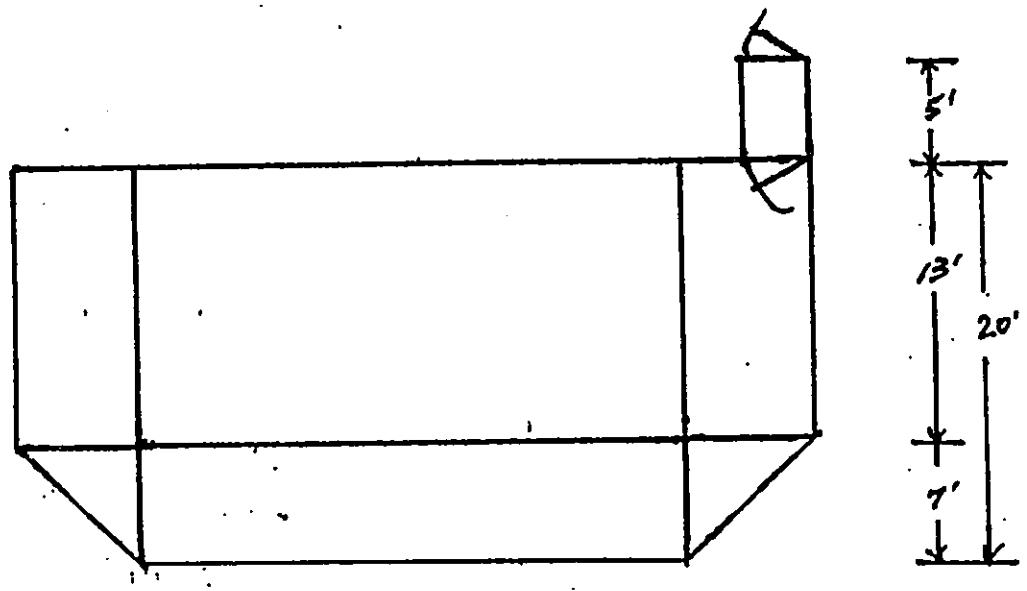
Dear Mr. Lucas:

Thank you for your September 24, 2003, letter requesting comments and concerns about your plans to demolish three aviaries and replace them with a single, larger enclosure.

This office has no comments on the proposal.

Aloha,

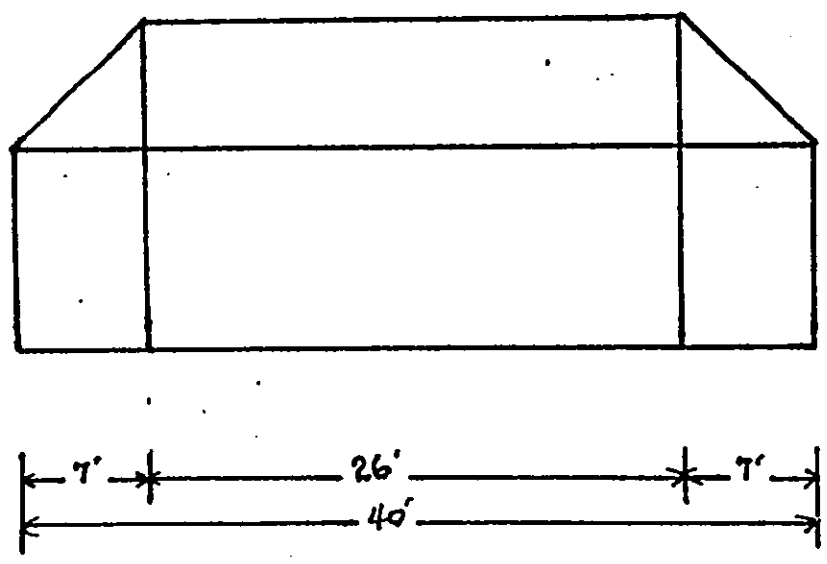
Harry Kim
MAYOR



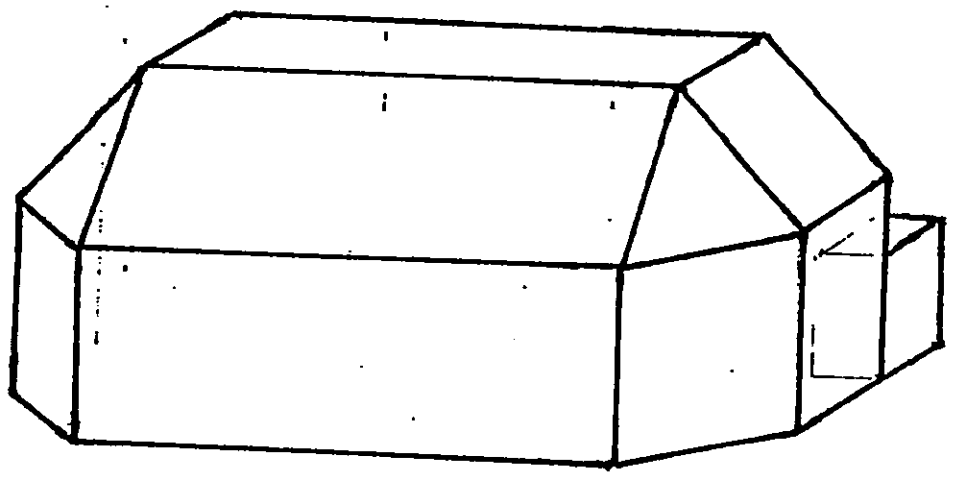
Proposed Aviary

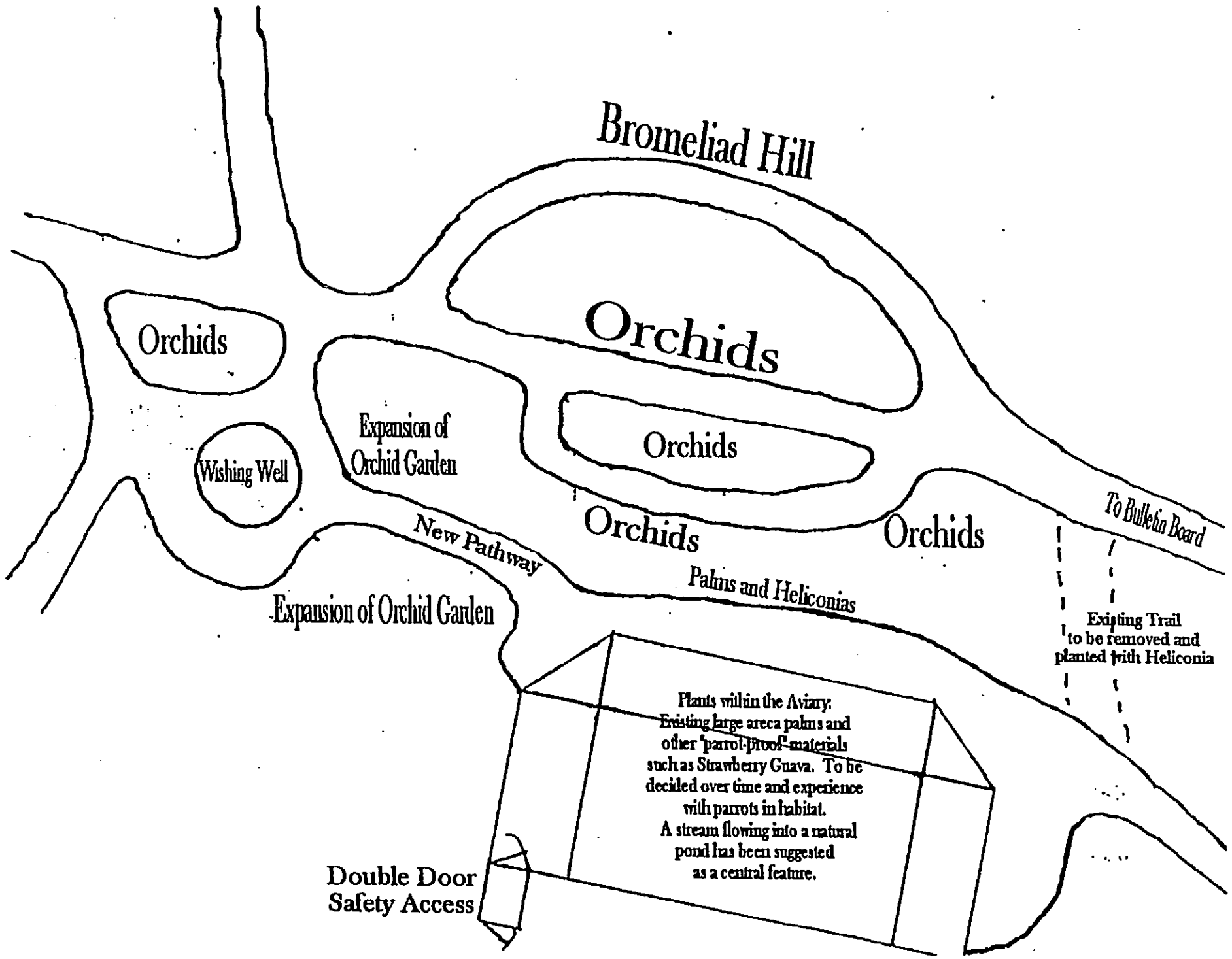
Elevation & Plan Views

EXHIBIT 5



Proposed
Aviary
Angle View




Bromeliad Hill
Orchids
Orchids
Expansion of
Orchid Garden
Wishing Well
Orchids
Orchids
Orchids
To Bulletin Board
New Pathway
Palms and Heliconias
Expansion of Orchid Garden
Existing Trail
to be removed and
planted with Heliconia
Plants within the Aviary:
Existing large areca palms and
other "parrot-proof" materials
such as Strawberry Guava. To be
decided over time and experience
with parrots in habitat.
A stream flowing into a natural
pond has been suggested
as a central feature.
Double Door
Safety Access

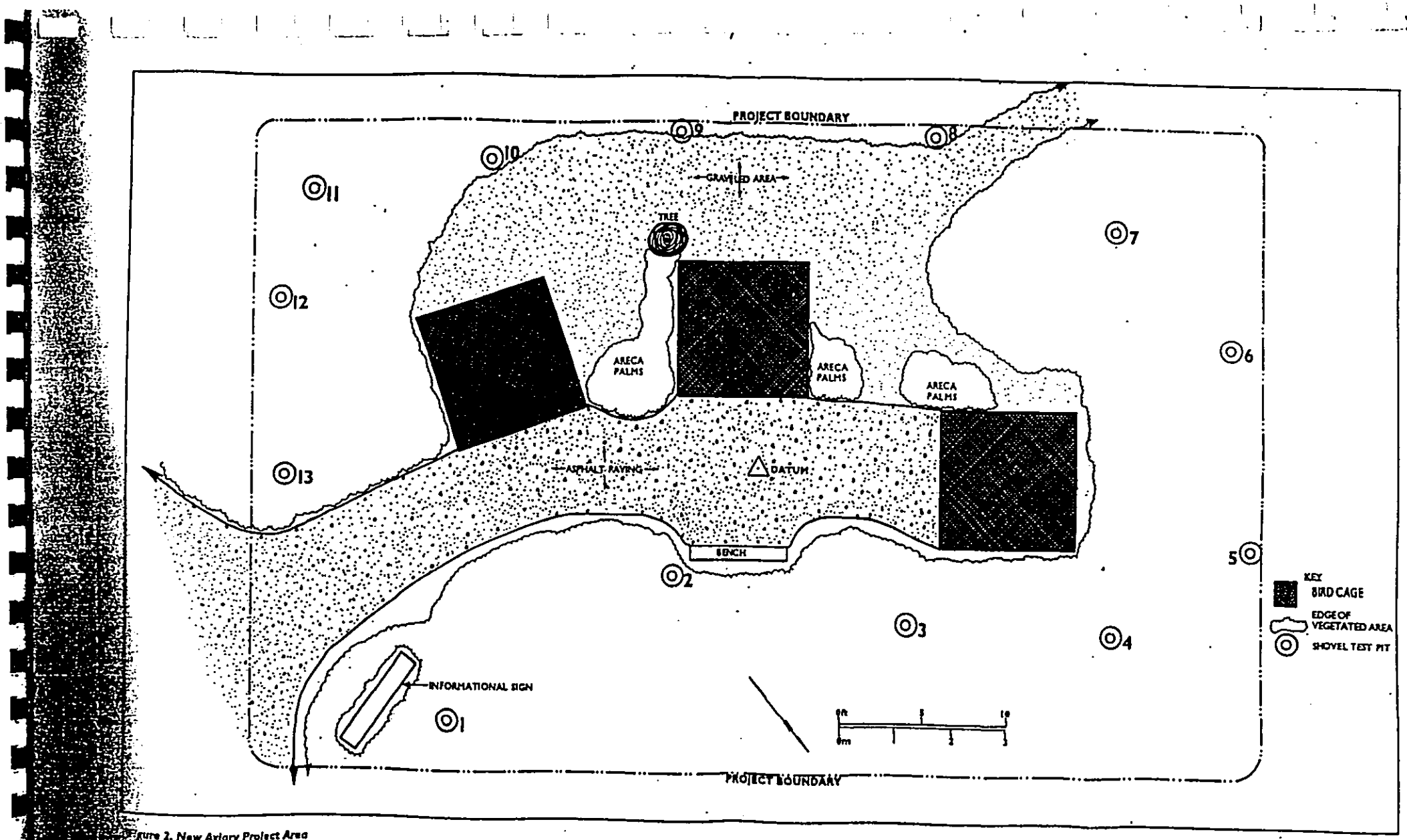


Figure 2. New Aviary Project Area

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
Western Region Natural Resources and Research Division
National Park Service

Honolulu, Hawaii

December 1990

EXHIBIT 6

JOHN WAIHEE
Governor, State of Hawaii

COMMISSION ON WATER RESOURCE MANAGEMENT
WILLIAM W. PATY, Chairperson
JOHN LEWIN, M.D.
MICHAEL J. CHUN, Ph.D.
ROBERT S. NAKATA
RICHARD H. COX, P.E.
GUY FUJIMURA

DEPARTMENT OF LAND AND NATURAL RESOURCES
WILLIAM W. PATY, Chairperson
Commission on Water Resource Management

MANABU TAGOMORI, P.E.
Deputy for Water Resource Management

NATIONAL PARK SERVICE
James Ridenour, Director

WESTERN REGION
Stanley T. Albright, Regional Director

DIVISION OF PLANNING, GRANTS AND ENVIRONMENTAL QUALITY
James Huddleston

RIVERS AND TRAILS CONSERVATION ASSISTANCE PROGRAM
Martha Crusius

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.**

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

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

Stenogobius genivittatus,
'o'opu naniha

Awaous stamineus,
'o'opu nakea

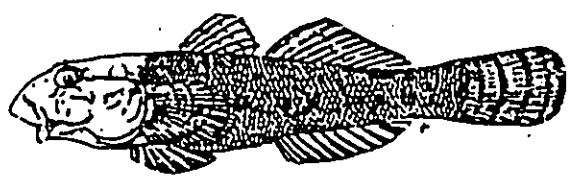


Figure 3. Awaous stamineus 9.0-cm (SL) male

Sicyopterus stimpsoni,
'o'opu nopili

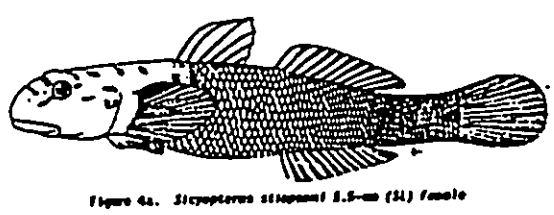


Figure 4a. Sicyopterus stimpsoni 5.5-cm (SL) female

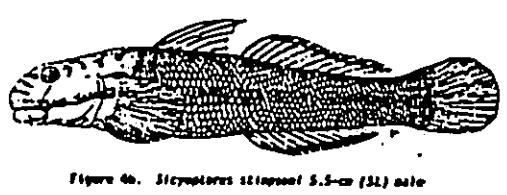


Figure 4b. Sicyopterus stimpsoni 5.5-cm (SL) male

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

Figure 6a. Lentipes concolor 6.0-cm (SL) female

Figure 6b. Lentipes concolor 5.0-cm (SL) male

Macrobrachium grandimanus,
'opae 'oeha'a

Atyoida bisulcata,
'opae kala'ole

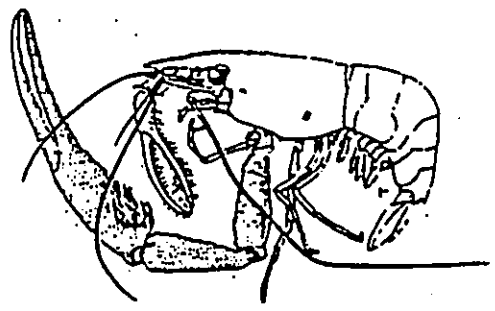


Figure 8. Macrobrachium grandimanus 22-mm POCL (Male)

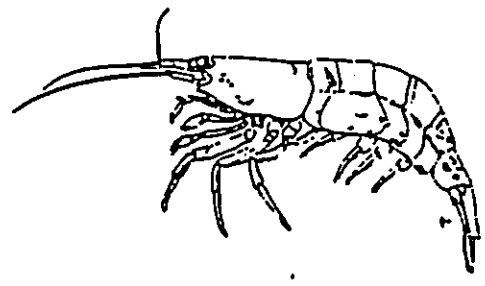


Figure 7. Atyoida bisulcata 8 mm (Post-Orbital Carapace Length (POCL)

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 1.8-cm shell width

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

15 April 1996

MEMORANDUM

TO: Bill Devick
FR: Bob Nishimoto
RE: Stream survey: Alakahi and Onomea streams, Hawaii Island

On March 6, 1996 Division personnel conducted an underwater visual survey of the lower sections of Alakahi and Onomea Streams, from the river mouth to the Old Mamalahoa Highway. We used the DAR Point-quadrat survey technique to census the macroorganisms in these streams.

A total of 13 qudrats were sampled in Alakahi stream, ranging from sea level (0 ft.) to 110 ft. elevation. The *aholehole,* a nearshore estuarine species, occurred in the lower stations. The fishes were all juveniles ranging in size from 1 - 2.5 inches total length (TL). Both lower elevation native gobies were also present (*o'opu akupa* , *o'opu naniha*) but were relatively uncommon. The *akupa* was large, averaging 6.5 in. TL. There was only one *naniha* observed. This species prefer the lowest stream section in quiet waters and preferably a sand bottom. The most common goby in this stream was the *o'opu nakea*, a mid-level stream occupant. It occurred in about 20% of the sample quadrat and ranged in size from 2.0 to 5.0 in. TL. The upper-level goby, *o'opu nopili*, was observed in only 1 quadrat. This species prefer a high gradient stream with fast flow. The most common stream organism, by far, was the introduced Tahitian prawn, Macrobrachium lar. They were present in about 86% of our sample quadrats. These prawns, unlike the native *'opae*, prefer a pond habitat.

The lower stream section of Onomea stream, from sea level to 165 ft. elevation, was surveyed. A total of 20 randomly selected quadrats were sampled. Like Alakahi stream, *aholehole* occurred at the stream entrance and were all juveniles, ranging in size from 1.5 to 2.0 in. TL. *O'opu nakea*, common in Alakahi stream, was observed in only one sample. On the contrary, the *o'opu nopili* was very abundant, occurring in 45% of our samples. The Tahitian prawn was not as abundant as in Alakahi stream, occurring in only 40% of the sample quadrat.

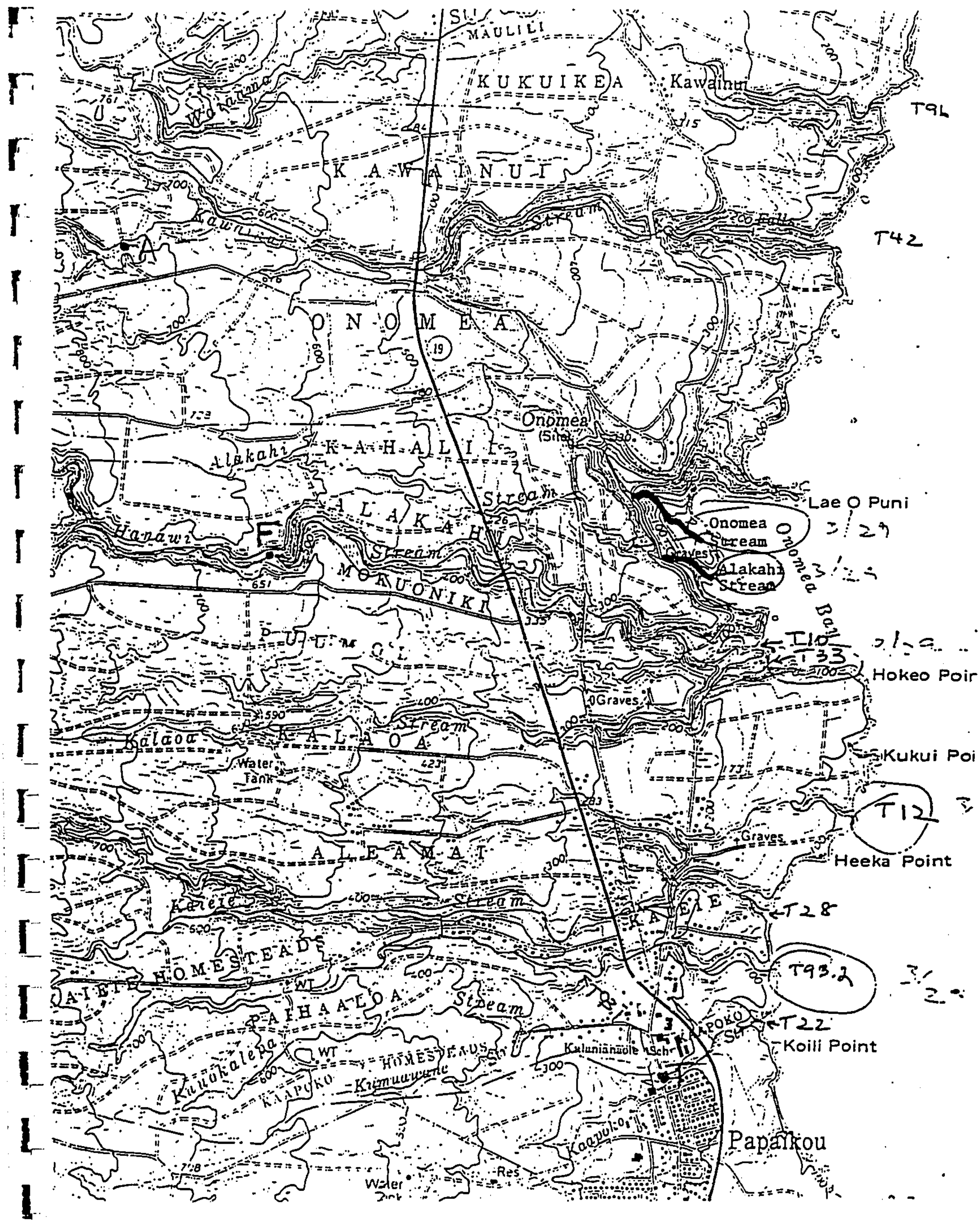
All the native gobies, except *o'opu alamo'o*, were present in these streams. The *alamo'o* commonly occurs in the higher elevations in

EXHIBIT 7

streams without a terminal waterfall, such as the Alakahi and Onomea. We plan to survey the upper reaches of these streams in the near future.

Robert Nishimoto jr.
ROBERT T. NISHIMOTO

xc: David Higa
✓Katherine Luga, Esq.
Scott Lucas



MAULILI
KUKUIKEA
Kawainui
KAWAINUI
Stream
Falls
ONOMEA
19
Onomea (Site)
KAHALII
Alakahi
Stream
ALAKAHI
Hanawi
Stream
MOKUONIKI
PUUMOI
Lae O Puni
Onomea Stream
Graves
Alakahi Stream
Onomea Bay
Hokeo Poir
Graves
Kalaoa
KALAOA
Stream
Water Tank
Kukui Poi
ALEAMAI
Graves
Heeka Point
Kaiele
Stream
KAIEIE
HOMESTEADS
PAIHAALOA
Stream
Kuukalepa
HOMESTEADS
KAAPOKO
Kulunianaole Sch
Koili Point
Kaapoko
Papaikou
Water Tank
Res
T9L
T42
T10
T33
T12
T28
T93.2
T22

Table 1. Table of common and scientific names of macroorganisms surveyed at Alakahi and Onomea streams, March 6, 1996.

COMMON NAME	SCIENTIFIC NAME
O'opu akupa	Eleotris sandwicensis
O'opu naniha	Stenogobius hawaiiensis
O'opu nakea	Awaous guamensis
O'opu nopili	Sicyopterus stimpsoni
O'opu alamo'o	Lentipes concolor
'Opae kuahiwi	Atya bisulcata
Tahitian prawn	Macrobrachium lar

7370A Kuamoo Rd., Kapaa, HI 96746
(808) 822-4984 ext 235 FAX (808) 822-2190
email address mkido@hawaii.edu
http://www2.hawaii.edu/hsrc/home/

The Hawaii Stream Research Center
University of Hawaii

25 February 1998

Scott Lucas
Executive Director
Hawaii Tropical Botanical Garden
RR 143-A
Papaikou, Hawaii 96781

Dear Scott,

I am sending you our project final report, "Baseline and Monitoring Studies of Onomea and Alakahi Streams, Hamakua Coast, Hawaii". It has been a very interesting and productive study adding immensely to our scientific knowledge about Hawaii's streams.

On behalf of the Hawaii Stream Research Center and Center for Conservation Research and Training at the University of Hawaii, I thank you and Mr. Lutkenhouse for funding the study. My research team is also extremely grateful for your staff's kind assistance, patience and graciousness during our field activities.

Please feel free to call me should you have any questions about the study results.

Sincerely,

Mike

M.H. Kido

cc Marvin Enokawa
Bill Devick
Bob Nishimoto
Jeff Burgett
Gordon Smith

EXHIBIT 8

Baseline and monitoring studies of Alakahi, and Onomea streams, Hamakua Coast, Hawaii.

The Hawaii Stream Research Center
University of Hawaii (Center for Conservation Research and Training)

Michael H. Kido
Anne M. Brasher
Charles Chong
Julia I. Devrell

Final Report

for

The Hawaii Tropical Botanical Garden

January 31, 1998

Table of Contents

Project Background and Logistics, Physicochemical Comparisons, and Benthic Studies
Michael H. Kido

Background

This study was conducted by personnel associated with the Hawaii Stream Research Center (HSRC)(University of Hawaii) and originated in response to concerns raised by the US Fish and Wildlife Service (USFWS) and the State Division of Aquatic Resources (DAR) about the impacts of two unpermitted diversions on Onomea and Alakahi Streams, installed by the Hawaii Tropical Botanical Gardens (HTBG) in 1979 and 1989 respectively. Removal of these two diversions was required by the Hawaii Board of Land and Natural Resources in early September 1997. Additional issues included the impact on streams of HTBG's planned expansion in the area and their proposed future water withdrawals from Onomea and Alakahi streams.

Figure 1. Onomea Stream/Bridge

Our purpose in this study was to assist the HTBG, as well as State and Federal agencies, in developing responsible long-term stream and watershed management plans for lower Onomea/Alakahi (Fig. 1-2) streams by: 1. collecting baseline data on stream biological quality (as evaluated by metrics including fish, invertebrate, and algal abundances and composition); and 2. establishing a stream monitoring program to provide a basis for evaluating variation in functional processes within- and between-streams over time. It was not the purpose of the HSRC to intercede in legal or management decisions or recommendations made by State or Federal agencies regarding HTBG activities. Our intent was rather to work within management guideline requirements imposed by these agencies to provide needed scientific data and to assist the HTBG during the study period to comply with required stream protection and environmental mitigation efforts.

Figure 2. Alakahi Stream/ culvert activities. These two streams are the smallest in the complex based on estimated stream length

Study Area

Four streams (Kalaoa, Hanawi, Alakahi, and Onomea) discharge into Onomea Bay between Lae O Puni and Hokeo Point in close proximity to each other (Fig. 3). Alakahi and Onomea streams flow through the HTBG property and are thus directly influenced by Garden

(4.2 km and 2.3 km respectively). Onomea originates at around 299 m and Alakahi around 229 m elevation (Fig 3). These two streams, therefore, have relatively small drainage areas. Hanawi, in comparison, has its origins near 914 m elevation and travels 13.2 km to the ocean. Kalaoa stream originates at about 348 m elevation and travels a distance of 4.7 km to Onomea Bay. The four streams enter Onomea Bay within a distance of each other of about 0.6 km of coastline and are within 1.6 km of each other at an elevation of around 244 m elevation (Fig. 3).

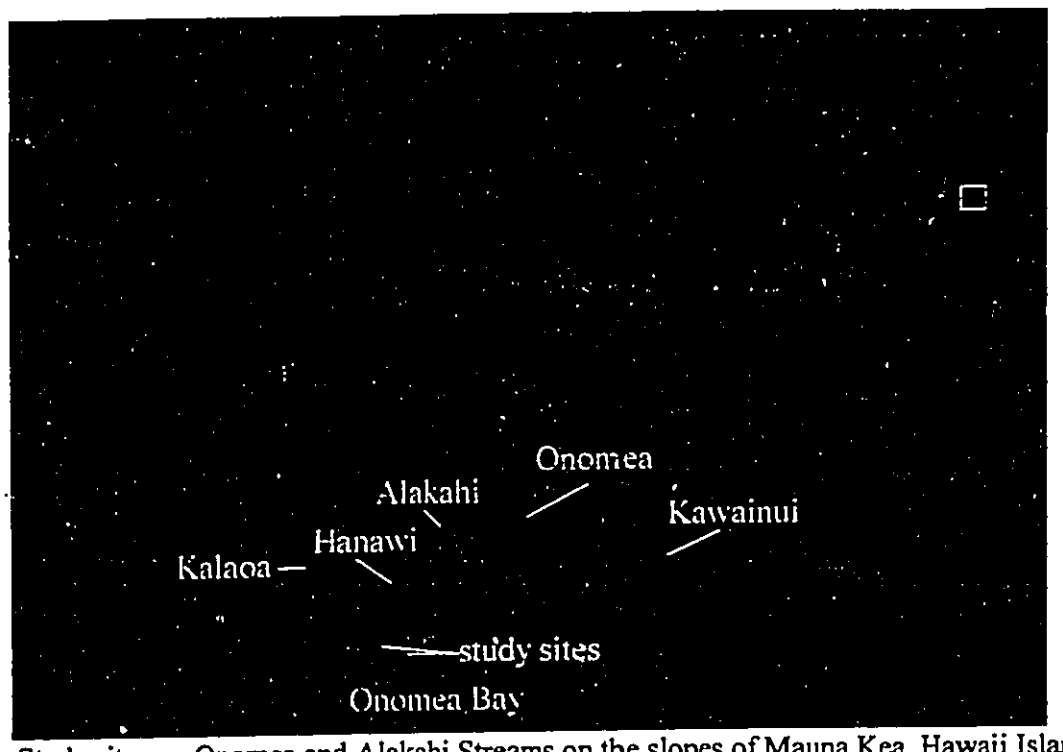


Figure 3. Study sites on Onomea and Alakahi Streams on the slopes of Mauna Kea, Hawaii Island.

Previous Studies

In the Hawaii Stream Assessment (HSA)(1990), only Alakahi and Hanawi streams are rated for "Aquatic Resources Status". Alakahi Stream was reported as having "substantial" aquatic resources; however, no survey date or other biological resource data is listed. Hanawi was rated as "Outstanding" with the presence of all native indicator stream taxa. Timbol and Maciolek (1978) classify both Alakahi and Onomea as "Limited-consumptive", continuous streams that were diverted and extensively crossed by roadways but not channelized. The Hilo staff of the State Aquatic Resources Division (DAR) surveyed Alakahi and Onomea streams from their river mouths to the Old Mamalahoa Highway using the "DAR point-quadrat method" in March 1996. The DAR survey found that while native stream fishes were present in both streams, their populations were not robust. The most common native fish species in Alakahi stream was *Awaous guamensis* (*'o'opu-nakea*) while *Sicyopterus stimpsoni* (*'o'opu-nopili*) was reported as being more abundant in Onomea stream. No native invertebrates were reported in the survey; however, the introduced Tahitian prawn, *Macrobrachium lar*, was reportedly very abundant in both streams.

Study Rationale

The proximate nature of Alakahi and Onomea streams necessitates a "cross-ecosystem analysis" (Kelly and Levin, 1986) to define local ecology. Although few "cross-stream" comparisons have been undertaken in Hawaii, data on "between-stream" relationships provide useful comparisons of stream functional processes, an assessment of regional stream quality, and information needed for conservation planning and managment. For Alakahi and Onomea streams, therefore, this study was designed to provide baseline data on resident aquatic species and compare key physical and biological attributes/processes in these streams as a means of assessing biotic variation (natural vs man-induced) in these proximate streams over time.

Study Objectives:

For the study period in Onomea and Alakahi Streams:

1. Assess and compare within- and between-stream variance in physicochemical attributes (slope, sinuosity, stream discharge, substrate composition and particle size, temperature, pH, dissolved oxygen, and conductivity).
2. Create a baseline list of resident aquatic species..
3. Assess and compare processes affecting the abundances of algal and invertebrate communities;
4. Assess and compare relative abundances/composition of native and alien stream macrofauna.

Materials and Methods

Physicochemical Comparisons

Because the presence of the concrete diversions in both Onomea and Alakahi Streams was the primary impetus for initiation of this study, sites were established on both streams to include these structures. Both streams had steep waterfalls below the diversions and these drop-offs were used to delineate the beginnings of the 100 m length study sites. Sites were situated at nearly identical elevations (39 m elevation for Alakahi and 38 m elevation for Onomea) and both streams passed under Mamalahoa Highway (Alakahi through a culvert and Onomea under a bridge). The similarities in physical setting presented an ideal situation for comparing physical and biotic attributes/processes within and between these proximate Hamakua coast streams.

Palmer et al. (1997) present a convincing case for the importance of variance in habitat structure as an appropriate ecological metric when assessing biotic processes in streams. In this study, we follow Palmer et al.'s (1997) use of coefficient of variation to quantify spatial variability. To collect spatial data for an assessment of within-stream variance in physical habitat characteristics, both 100 m study sites were measured and flagged at 5 m intervals. Physical variables were measured at these intervals and summed among intervals to provide a mean and standard deviation for that variable within-streams. Between-stream comparisons were then made possible using these data. Incremental rise in slope for each 5 m linear upstream-distance was measured with a 10X hand-level and measuring rod (1.6 m length). Sinuosity, or the angular change in channel flow, was measured using a compass by estimating the direction of flow (degree change from North) at each 5 m increment, sited on a stationary measuring rod (1.6 m

length) positioned at the stream's edge. Mean flow (cms) and depth (m) at each 5 m increment were measured in 0.25 m intervals across the stream using a Swoffer flow meter and top-setting wading rod. Dissolved oxygen (mg L), % oxygen saturation, conductivity (mS/cm), pH, and temperature (deg C) were measured *in situ* (center stream and equidistant from both banks) using a HYDROLAB Datasonde 3 multiprobe with Scout2 data display.

Mean and variance in substrate particle size and % exposed surface was estimated at each 5 m increment (M. Kido unpublished method) using a sq m grid delineated across the stream channel by a secured meter-flagged line (see Kido 1997a). This grid was also used to sample the benthic environment (described below). In each sq m cell, a PVC frame was used to delineate a 1/6 sq m "major subunit" and the percent of out-of-water substrate (% exposed boulder) in each "major sub-unit" was estimated. "Major sub-unit"estimates were subsequently combined for each sq m cell and summed within- and among-lines to provide mean and variance for % exposed boulder for each 5 m increment and for the 100 m study reach. The PVC frame was itself divided into 6 subunits using rubber bands stretched across the frame to create a six-celled grid of "minor subunits". This system was created so that a die could be cast (ie. from one to six) in the field to randomly select a "major" or "minor" subunit for sampling substrate particles on the stream bottom. Based on random numbers generated by cast of the die, a "major sub-unit" was selected and a particle found within the "major subunit" was measured for longest length using a 50-cm tree caliper or 1.6 m measuring rod depending upon the size of the particle discovered. If several or many small particles were found in the "major subunit' a second random number was generated to determine the location of the "minor subunit" to be sampled. Five random numbers were generated for each sq m cell across the stream cross-section and sampled in this manner. Mean particle size and variance were determined among sq m cells within-lines and among lines within-streams. Bedrock encountered on the stream bottom was assigned a value of 450 cm and silt particles too fine to be measured with the calipers were assigned a value of 0.01 cm. Large mean particle values with low variance therefore indicated bedrock bottoms and small mean particle values with low variance high silt environments.

For between-stream comparisons, attribute means were compared through analysis of variance (ANOVA)(GLM Procedure, SAS Institute, 1992). Depth and substrate measurements were normalized using a square root $(x + 1)$ transformation. Slope, sinuosity, and chemical measurements were transformed using log $(x + 1)$. Coefficient of variation (CV = Standard deviation/ mean) was used as a comparative measure of variability. Only untransformed means are reported and the use of the term "significant" indicates statistical significance (ie. $P < 0.05$) even though probability values are not specified in the report for simplification.

Standing Biomass of Algae and Invertebrates

At the beginning of the study, standing crops of algal and invertebrate biomass were estimated through benthic collections at approximately every 10 m increment using the previously described sq m cross-stream grid. In each sq m cell, estimates of particle sizes (described previously) were used to determine the predominate particle sizes found in the cell. Particles >30 cm in longest length (phi scale -8; Cummins 1962) were sampled using a standard Surber net (Surber 1937) and smaller particles through removal (see Kido 1996c for a description

and rationale for the method). A minimum of three Surber scrapes and/or three rocks were sampled in each sq m cell depending on resident particle sizes. Substrate surfaces were scraped thoroughly with a stiff brush, the contents washed into a nitex fabric square and subsequently stored in 10 % buffered formalin. Surber nets sample an standard area of 0.09 sq m and rocks were measured for longest length and width to provide an estimate of rock surface area sampled. These values were used to calculate algal and invertebrate densities (biomass g/ sq m). In the laboratory, algae and invertebrates were processed, identified, and quantified as in Kido (1996a, 1996b). Algal samples were ashed after drying/weighing at 450° C for three hours in a muffle furnace and results are reported as g AFDM per sq m (ash free dry matter). Invertebrate taxa were dried, and weighed directly; therefore, data are given as biomass g per sq m.

Stream Functional Processes

Hardboard multiplate samplers were used to assess the dynamics of algal/invertebrate colonization and deposition of sediment, coarse particulate organic matter (CPOM)(usually > 1mm pieces of vegetative matter), and fine particulate organic matter (FPOM)(usually organic detrital particules < 0.45 mm) in the study streams over the study period. These samplers have a standard surface area of 0.16 m^2. Three samplers were used per replicate and three replicates were implanted in Alakahi and Onomea streams at low-middle-high elevation locations within the 100 m study reaches. Samplers within-replicates were secured to the stream bottom with lag-screws drilled into the rock substrate and placed within an area of about 1 sq m. Depth (m) and mean flow (cm/sec) for sampler replicates within-streams measured on the same day were 0.01 + 0.014 cm/sec (CV=3.00), 0.16 + 0.018 m (CV=0.344) and 0.05 + 0.016 cm/sec (CV=0.941), 0.14 + 0.024 m (CV=0.519) for Alakahi and Onomea streams respectively.

Figure 4. Hardboard samplers.

Samplers were left in the stream for 3-4 week periods. Upon removal, bottom plates from each sampler were stored in a dark container for total chlorophyll analysis and the remaining plates disassembled and scrubbed clean of organic material. This material was processed as described earlier for benthic samples. Algal, bryophyte and FPOM densities were determined by estimating % surface area coverage in the sample and multiplying this value by ash free dry weight (AFDW) of the entire sample. CPOM densities were estimated similarly or through direct removal of vegetative pieces with subsequent drying, weighing, and ashing. Sediment densities were assumed to be the inorganic residues remaining after organic material had been burned away during combustion in the muffle furnace. Samplers have identical surface areas; therefore, biomasses of algal and invertebrate taxa were only standardized by days of stream exposure giving data comparable as a rate of biomass accumulation over time (biomass g AFDM per day).

Total Primary Production

Total chlorophyll as an estimate of overall instream primary productivity was determined from the bottom plates of each sampler which were frozen after removal from the stream in dark containers until processing. Individual plates were removed from the freezer and scraped clean of organic material which were filtered under pressure on to a burnable filter (4.5 cm diameter). Filters were carefully placed into centrifuge tubes containing 10 mL methanol and returned to the freezer for 24 hr. In a dark room, 2.0 mL methanol and 0.4 mL of sample liquid were placed into a sample cuvette with an auto-pipette and mixed. Samples were read on a digital fluorometer (Sequoia-Turner, Model 450) zeroed on 2 mL of pure methanol. Filters were burned in a muffle furnace and weighed to determine AFDW. Plates were assumed to have identical surface areas; therefore, chlorophyll units were only standardized by days of stream exposure and are reported as accumulating chlorophyll units per day.

Results and Discussion

Physicochemical Comparisons

In the two study reaches compared, Onomea was found to be significantly deeper and wider than Alakahi with more uniform depth (ie. lower variance)(Table 1). This characteristic was likely maintained by supplemental flow diverted into Onomea from adjacent Kawainui stream entering above the study site. It was no surprise, therefore, that Onomea also had significantly higher flow velocity even though Alakahi had greater overall slope (Table 1). Higher stream velocity in Onomea was also supported by fewer changes in flow direction (ie. lower sinuosity) which allowed the stream to flow straighter in long, steep, high velocity channels (Fig. 5). Alakahi, in comparison, meandered considerably exhibiting significantly greater sinuosity (Table 1) which resulted in shorter, slower-flowing channel units separated by pools and braided segments. Stream width in Alakahi, not surprisingly, also exhibited higher variance than Onomea due to marked widening of the stream between channel units (Table 1).

Attributes	Onomea (38 m elevation)		Alakahi (39 m elevation)	
	mean	CV	mean	CV
flow velocity (m/ sec)	0.14 + 0.034	2.448	0.04 + 0.006	1.278
depth (m)	0.41 ± 0.021	0.551	0.30 ± 0.290	0.922
width (m)	1.73 + 0.324	0.675	1.34 + 0.397	1.106
slope (m rise/ m linear distance)	0.16 ± 0.033	0.929	0.20 ± 0.025	0.515
sinuosity (deg change/ m)	2.47 ± 0.529	0.958	4.75 ± 0.748	0.630
substrate particle size (m)	2.27 + 0.213	0.864	0.55 + 0.067	0.723
% exposed boulder	0.01 + 0.012	2.332	0.48 + 0.027	1.574
dissolved oxygen (mg/L)	8.15 + 0.030	0.162	7.89 + 0.066	0.036
pH	7.58 + 0.011	0.007	7.56 + 0.016	0.010
conductivity (mS/cm)	0.07 + 0.001	0.008	0.09 + 0.001	0.016
temperature (deg C)	21.19 + 0.039	0.009	21.39 + 0.019	0.004

Table 1. Comparison of means and spatial variability (coefficient of variation) of physicochemical attributes of Alakahi and Onomea streams.

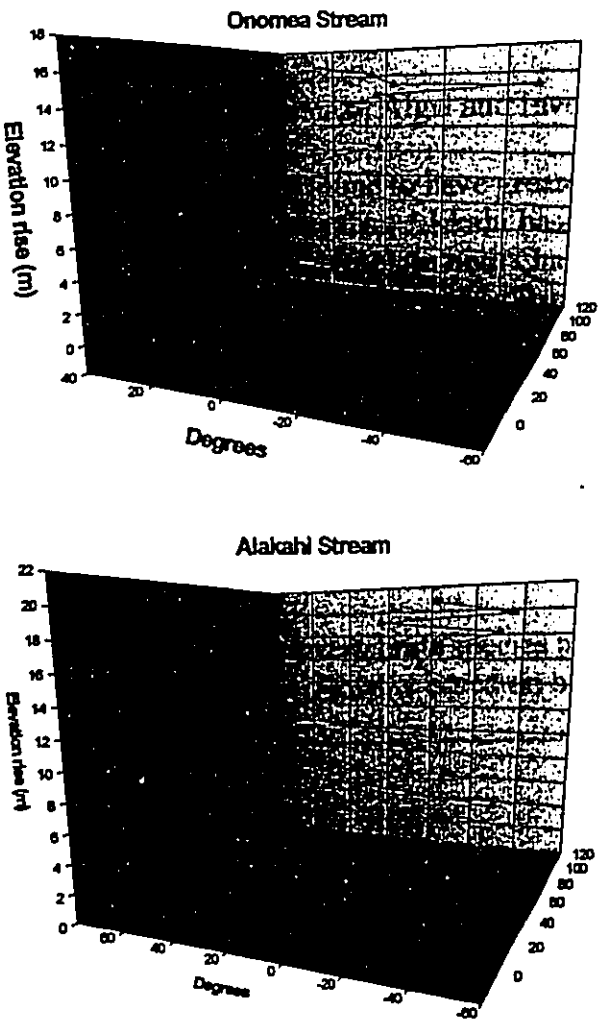


Figure 5. Sinuosity comparisons.

The two streams, although geographically adjacent, exhibited distinctly different substrata apparently because they cut through two distinct types of basalt lava formations. Indeed, it may likely have been differences in erosion resistance of these formations that ultimately dictated the stream's physiognomies. Onomea flowed through a solid vein of erosion-resistant basalt bedrock which comprised most of the stream bottom. This bedrock substrate was found to be overlain by cobble-sized particles which constantly travel downstream. Deposition of this material occurred primarily in *scour pools and low-slope segments*. Onomea, therefore, exhibited large mean particle size (due to preponderance of bedrock), low mean % exposed boulder, but high variability in these attributes over the study reach (Table 1). Meandering, slower-flowing Alakahi cut through a less-erosion resistant basalt vein resulting in a talus-type substrata characterized by high coverages of meter-sized (or greater) exposed substrate and many areas of gravel/silt deposits (Table 1).

These physical habitat differences likely influenced measurable chemical differences in the streams themselves. Onomea, for example, was found to have significantly higher dissolved oxygen concentrations than Alakahi with higher variance suggesting that relatively high oxygenation was occurring in certain segments of the study reach. These supersturated zones were determined to be areas of high velocity, slope and turbulence in Onomea not present in Alakahi. Mean water temperature and conductivity were significantly higher in Alakahi while no between-stream differences were determined for pH (Table 1). The Onomea study reach was more open in riparian canopy and thus more exposed to sunlight; however, lower stream temperatures may have been maintained by swifter flows and the influx of diverted water from Kawainui stream. As expected, higher conductivity was found in Alakahi as nearly totally closed riparian canopies likely inputed large quantities of organic detritus into the study stream reach.

These comparisons of Alakahi and Onomea suggested that these proximate streams differed significantly in physical characteristics and resultant dynamic physical processes occurring within-stream. The supplemented flow into Onomea from Kawainui likely played a significant role in influencing and maintaining these differences. The type of basaltic lava

through which the streams flowed also had a major influence on the character of the stream bottom as well as on the manner in which the stream meandered. The question remained, at this point in the study, as to how these physicochemical differences between-streams influenced their biotic properties and processes.

Benthic Comparisons of Algal and Invertebrate Populations

Onomea was found to have greater species diversity and significantly higher biomass of algae and invertebrates than Alakahi based on initial density estimates obtained by sampling of the stream bottom (Table 2). In both Onomea and Alakahi, the blue-green alga *Phormidium retzii* was found in highest abundance forming dense, dark-green mats in thick layers of fine particulate organic matter (FPOM). An aquatic bryophyte (moss), tentatively identified as *Champtochaete* sp., was also found in both streams but in significantly higher densities in Alakahi. Immature midges (primarily adventive *Cricotopus bicinctus*)(Chironomidae) were the most abundant invertebrate found in both streams but in significantly higher densities in Onomea. Therefore while the two streams shared many of the same algal and invertebrate species, they almost invariably exhibited higher densities in Onomea (except for the moss).

Table 2. Algal and invertebrate species and density comparisons found in study reaches of Onomea and Alakahi streams based on benthic sampling (19-20 March 1997).

	Onomea	**Alakahi**
Algae	(g AFDM/ sq m)	(g AFDM/ sq m)
Chlorophyta	0.019 + 0.0127	not collected
Cladophora sp.	0.066 + 0.0421	0.001 + 0.0004
Spirogyra sp.	0.479 + 1.2659	not collected
Stigeoclonium subsecundum	0.625 + 0.2631	0.004 + 0.0066
Phormidium retzii (Cyanophyta)		
Bryophyta: Lembophyllaceae: Bryales	0.018 + 0.0119	0.037 + 0.0222
Champtochaete sp.	(mg/ sq m)	(mg/ sq m)
Aquatic Arthropods (* native)		
Insects- Diptera	3.771 + 2.0048	1.072 + 0.4571
Cricotopus bicinctus (Chironomidae)	0.037 + 2.0048	not collected
*Scatella cilipes** (Ephydridae)	0.389 + 0.2875	0.044 + 0.031
Limonia sp. (Tipulidae)		
Tricoptera	0.202 + 0.1397	0.193 + 0.1668
Cheumatopsyche pettiti (Hydropsychidae)	0.674 + 0.4355	0.001 + 0.0001
Hydroptila arctia (Hydroptilidae)	0.001 + 0.0001	not collected
Collembola	0.007 + 0.0006	not collected
Crustacea - *Atyoida bisulcata** (Decapoda)		

Native aquatic insects were only collected in Onomea. Adult male *Megalagrion hawaiiense* were observed and a few naiads collected in a small waterfall which emptied into the stream approximately 50 m upstream of the study site's 100 M mark (~ 50 m elevation). Pupal

cases with emerging native *Neoscatella cilipes* (Ephydridae:Shore flies) were collected during benthic sampling; however, no adults were captured while sweep-netting the stream. This suggests that populations of this active native stream fly in Onomea were small.

Functional Processes

Primary Production

Primary productivity as measured by accumulating total chlorophyll units per day was significantly higher in Onomea than Alakahi over the study period (Fig. 6). This is supported by findings of greater initial standing crops of algal biomass discussed earlier for Onomea. Although Onomea was determined to be a more productive stream; both streams exhibited similar trends in primary productivity with a peak occurring in the spring, falling to lows in the summer, and increasing to moderate levels in the fall. In the absence of continuous flow and weather data, however, it is difficult to ascertain the respective roles played by natural variation of environmental factors such as periodic flood disturbance, light, and/or temperature in influencing the observed patterns in primary productivity.

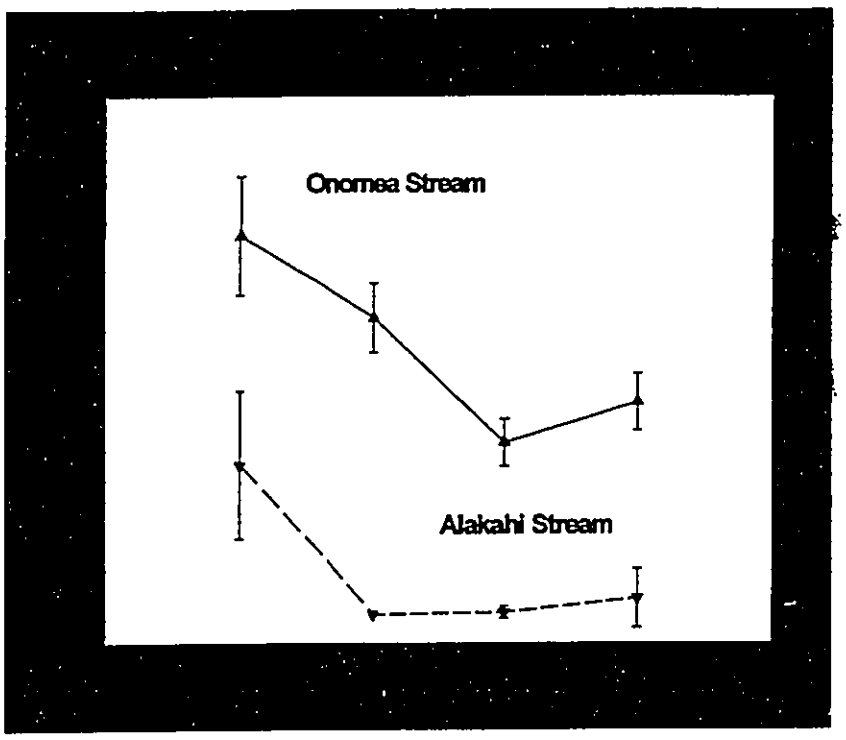


Figure 6. Comparison of instream primary production.

Algal and Invertebrate Dynamics

Five filamentous algal and twenty-one invertebrate species were collected off hardboard multiplate samplers implanted in Onomea and Alakahi streams over the study period (Table 3). While no new algal species were collected as compared to those obtained during the initial benthic assessment, five previously uncollected arthropod taxa, a nemertean (proboscis worm), and at least two species of aquatic annelids were obtained from the implanted hardboard samplers. For nearly every algal and invertebrate taxa, rates of colonization were higher in Onomea as compared to Alakahi with the exception of an adventive dragonfly *Ischnura* sp. (not collected in Onomea) and aquatic Collembola (springtails)(Table 3). These data supported the notion that Onomea was a significantly more productive stream than neighboring Alakahi.

Table 2. Comparison colonization rates for algal and invertebrate species collected off hardboard multiplate samplers implanted in Onomea and Alakahi Stream (Apr to Oct 97).

Species	**Onomea Stream** mean g AFDM/ day + SE	**Alakahi Stream** mean g AFDM/ day + SE
Algae		
Cladophora sp. (Chlorophyta)	0.00025 + 0.000088	0.00086 + 0.000583
Spirogyra sp.	0.00218 + 0.000384	0.00013 + 0.000038
Stigeoclonium subsecundum	0.00072 + 0.000184	0.00026 + 0.000177
Phormidium retzii (Cyanophyta)	0.00284 + 0.001333	0.00031 + 0.000145
Hydrosera whamposensis (Chrysophyta)	0.00002 + 0.000017	>0.00001
Bryophyta-*Champochaete* sp (Bryales)	0.00001 + 0.000012	>0.00001
Invertebrates		
Insecta - Diptera	mean mg/ day	mean mg/ day
Cricotopus bicinctus (Chironomidae)	0.04944 + 0.015334	0.01603 + 0.005598
Limonia sp. (Tipulidae)	>0.00001	not collected
Scatella cilipes (Ephydridae)	0.00001 + 0.000011	not collected
Tricoptera		
Cheumatopsyche pettiti (Hydropsychidae)	>0.00001	>0.00001
Hydroptila arctia (Hydroptilidae)	>0.00001	not collected
Collembola	>0.00001	0.00003 + 0.000016
Odonata-Coenagrionidae-*Ischnura* sp.	not collected	0.00101 + 0.000910
Arachnida- Acarina (mites)	0.00006 + 0.000013	0.00053 + 0.000016
Micro-Crustacea		
Cladocera	>0.00001	not collected
Copepoda-Harpacticoida	0.00164 + 0.001348	0.00041 + 0.000229
Ostracoda	0.00003 + 0.000016	not collected
Nematoda	0.00007 + 0.000017	0.00002 + 0.000005
Nermetinea	0.00001 + 0.000001	0.00002 + 0.000005
Annelida		
Oligochaeta	0.00115 + 0.000595	0.00046 + 0.000292
Polychaeta	0.00004 + 0.000014	0.00003 + 0.000014

For invertebrates, the alien midge *Cricotopus bicinctus* was determined to be the dominant species collected in terms of accumulating biomass (Table 3). This is typical of Hawaii's streams today; however, the scarcity of alien caddisflies (*Cheumatopsyche petti* and *Hydroptila arctia*) was rather atypical as they are generally expected to be more common in flowing streams of this nature. Of particular interest, was the relative dominance of micro-crustacea and soft-bodied worm-like species collected in both Onomea and Alakahi through use of implanted samplers (Table 3). These forms did not show up in the initial assessment which utilized standard stream-bottom sampling methodologies. No identification keys were available for these tiny forms and little is known about their ecology in Hawaii; however, their presence in

lotic habitat and similarities in *in situ* colonization rates suggest that they are resident species in these two Hamakua Coast streams.

Overall rates of algal colonization were consistently higher in Onomea as compared to Alakahi regardless of season (Fig. 7, 8). Although the same algal species were found in both streams, their colonization dynamics differed markedly between-stream. For example, in Onomea stream two algal species, the blue-green *Phormidium retzii* and the green *Spirogyra* sp., consistently dominated the samplers with higher rates of colonization than other species (Fig. 7). A significant bloom occurred during fall (Oct 97) with both species exhibiting extremely rapid colonization as rates for other species declined (Fig. 7).

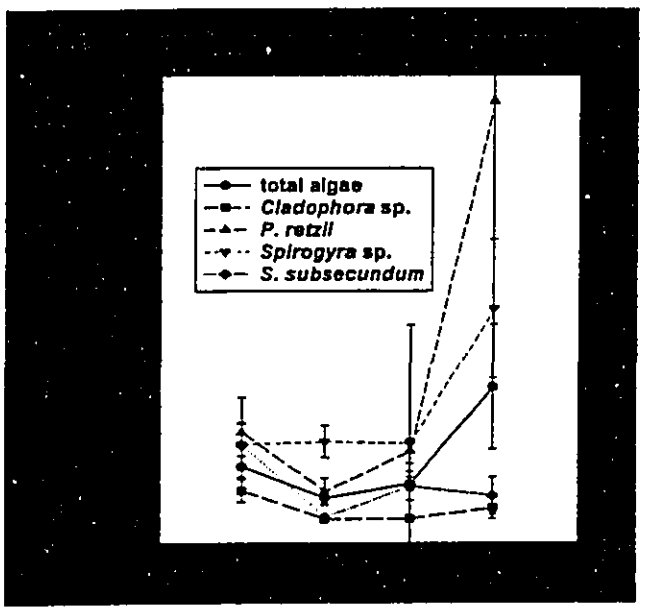


Figure7. Algal species dynamics in Onomea.

In contrast, samplers in Alakahi were dominated by three algal species. *P. retzii*, *Cladophora* sp., and *Stigeclonium subsecundum* (Fig. 8). *Spirogyra* sp., one of the two dominant Onomea algae, was relatively scarce in Alakahi and not a very productive species (Fig. 8) in that stream. The fall algal bloom observed in Onomea also occurred in Alakahi but only involved a single species (*Cladophora* sp.). While other resident algae in Alakahi declined in abundance, *Cladophora* sp. achieved comparable rates of growth to algal species in Onomea (Fig. 7,8).

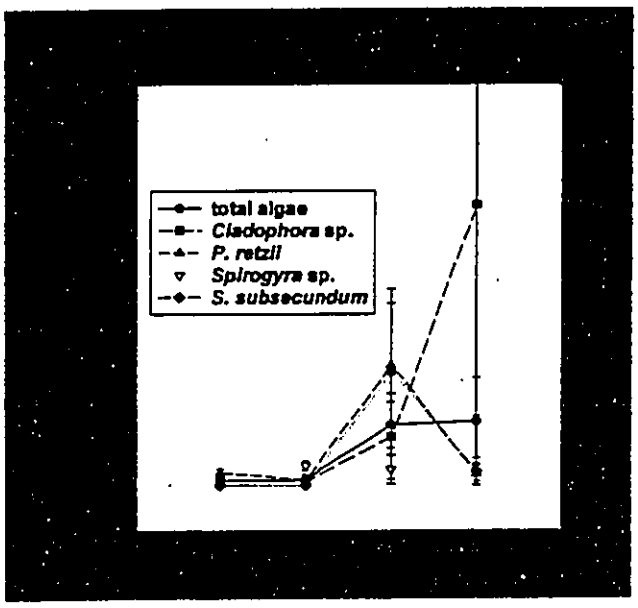


Figure 8. Algal species dynamics in Alakahi.

It is difficult to interpret these findings given that few cross-stream comparisons have been attempted in Hawaii, particularly those having to do with instream primary productivity and algal succession. It seems clear that the differences in physical characteristics determined for the two streams were translated into biotic differences as well. The importance of physical habitat (especially current regime) in influencing algal succession is well established (Stevenson et al. 1996). For algae, species abundances were likely mediated and maintained by relative differences in incident light, flow velocity, and nutrient input. Flood disturbance occurring unpredictably during the study period likely also played an overriding role in guiding the patterns observed as the ability for flood events to 'reset'

levels of algal abundance in Hawaiian streams has been previously demonstrated (Kido, 1997a). For the sake of generalizations, Onomea can best be described as a more-productive, swift-current stream and Alakahi as a less-productive, slow-current stream. Each system functions within a set of dynamic processes dictated by individual physionomies.

For invertebrate species, higher algal productivity in Onomea resulted in higher abundances (colonization rates) of the alien midge, *Cricotopus bicinctus*. This swift-water chironomid is becoming increasingly abundant in Hawaii's streams particularly those supporting robust populations of algae upon which they feed and reproduce. Interestingly, the abundances of micro-arthropod/worm-like species were similar in the two streams suggesting that these invertebrates were less dependent on algal abundance (ie primary productivity). Populations of these species may be more dependent upon terrestrial (external) sources of energy from organic matter input into the streams (ie. coarse and fine particulate organic matter).

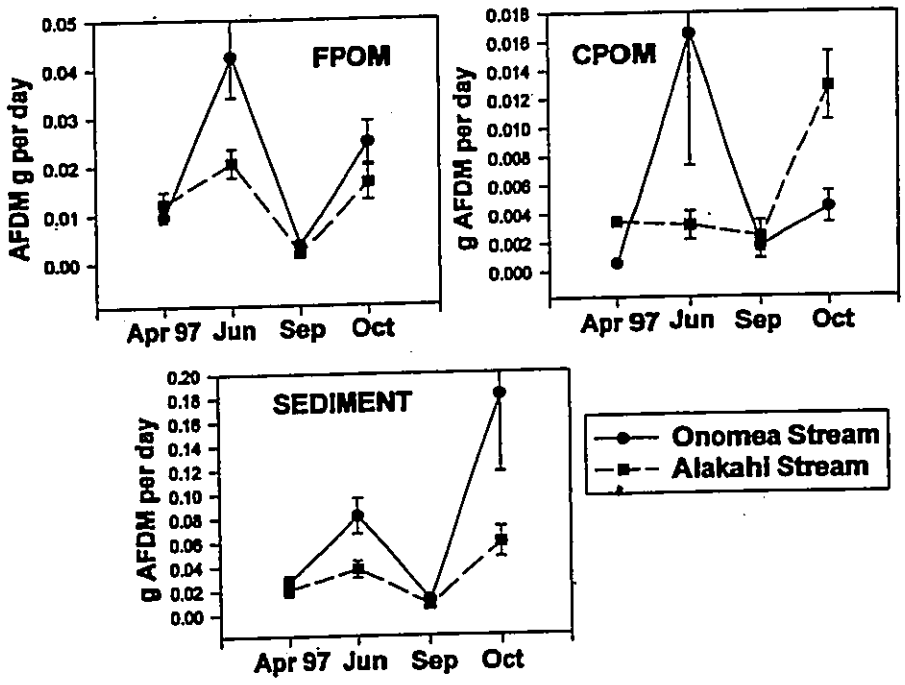


Figure 9. Organic matter inputs and sediment dynamics in Onomea and Alakahi.

Organic Matter Inputs and Sediment Dynamics

Onomea and Alakahi streams were found to have similar basal rates of CPOM, FPOM, and fine sediment accumulation over the study period; however, Onomea exhibited significantly greater peaks in deposition of these materials (Fig. 9). The similarities in pattern of fine sediment and FPOM accumulation in the two streams suggested that the dynamics of movement of these materials were being driven by processes occurring at the watershed scale (eg. heavy rain and/or flood events). The significantly greater rates of fine sediment and FPOM deposition which

periodically occurred in Onomea (Fig. 9) may have been related to events occurring in the Kawainui stream watershed via diverted water inputs and/or land-based processes/activities specific to the Onomea watershed. Similar causes may be invoked to explain spikes in CPOM deposition in Onomea which consisted primarily of decomposed leaf and branch fragments. In Alakahi, the large late summer-fall (Oct 97) input of CPOM (Fig. 9) consisted primarily of palm fruits/seeds and fresh leaves/branches which indicated a more local source of this material from the extensive riparian canopy which bordered the stream channel along the study reach. These findings suggested that coarse vegetative material in the study reaches entered the streams from areas upstream as well as directly in closed riparian canopy locations. The organic material accumulating in the study sites from upstream were highly decomposed indicating that breakdown occurs *in situ* as the material moves downstream. The coarse material provided a steady source of FPOM for reaches further downstream. Basal stream flow conditions moved FPOM, CPOM, and fine sediment steadily into the study reaches with occasional large pulses of material being deposited during flood events. In the absence of comparative data from other streams, it is not possible to determine if the rates of deposition are higher or lower than other streams in the State. Nearly all of the riparian vegetation along the segments of Onomea and Alakahi for this study were non-native, the upper reaches of which ran through abandoned sugarcane fields. This situation is likely typical of Big Island Hamakua streams today. Judging from the results of this study, watersheds/riparian zones supply significant quantities of organic material locally to these streams; however, little is known about the fate of this material or its role (or affect) in/on stream function.

Conclusions

The stream reaches studied in Onomea and neighboring Alakahi were found to differ significantly in physical attributes of depth, width, flow, slope, sinuosity, dissolved oxygen, and substrata even though sites were located at nearly identical locations. These physical differences translated into biotic differences as well with Onomea exhibiting significantly greater primary and secondary productivity. Native insect species were only found in Onomea; however, their populations were not robust. Interestingly, while the two streams shared similar assemblages of algae and invertebrates, population dynamics within-stream differed markedly yet exhibited similar overall seasonal trends. Coarse/ fine particulate organic matter and fine sediment continually settled in the study reaches coming from sources upstream or directly from localized riparian areas. Very large periodic inputs of this material were determined in Onomea and to lesser degrees in Alakahi. Diverted water from Kawainui stream into Onomea likely plays an important role in governing physical and functional processes in reaches below the point of entry of diverted water.

As for providing habitat for native amphidromous macrofauna (ie. *'o'opu, hihiwai,* and *opae*), the study reach in Onomea probably would be predicted as supporting higher populations based on the between-stream comparisons. Onomea's swifter-flow, higher oxygenation, and more complex substrate/channel unit characteristics provide more suitable physical habitat. The same conclusion would be reached based upon the availabilities and abundances of food species; however, overall densities of native macrofauna in both streams would be predictably low. Aquatic insect food biomass was quite low in both streams and primary production was based

primarily on the cyanophyte *Phormidium retzii* with periodic blooms of *Spirogyra* sp. and *Cladophora* sp. In this environment, *'o'opu-nakea* (*Awaous guamensis*) would probably be present (but not abundant) while *hihiwai* (*Neritina granosa*) and *opae* (*Atyoida bisulcata*) would be predictably rare most of the time because of the rarity of chlorophytes. The ready availability of epiphytic and free-living diatoms in Onomea (and to a lesser extent in Alakahi) indicated that the obligate herbivore, *Sicyopterus stimpsoni* (*'o'opu-nopili*), would at least be a common visitor to the study reach if not resident at times. Similarly, the *'o'opu-alamo'o* (*Lentipes concolor*) should be present, particularly with the micro-crustacean fauna available as prey. These food species appeared to fluctuate markedly in abundance during the study period and these fluctuations may be a factor which limits native macrofaunal populations over the long-term in both streams.

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EVALUATION OF PHYSICAL, CHEMICAL AND BIOLOGICAL PARAMETERS IN ONOMEA STREAM AND ALAKAHI STREAM

Anne M. Brasher

INTRODUCTION

A one year study (January 1997 - December 1997) was conducted to evaluate physical, chemical and biological parameters in Onomea Stream and Alakahi Stream in South Hilo, Hawaii. The study was designed to coincide with the removal of two unpermitted diversions, one each on Onomea and Alakahi Streams, installed in 1979 and 1989, respectively. Both dams were removed in September 1997, with data collected before, during and after the removal. The purpose of this study was to collect baseline information on stream conditions to assist the Hawaii Tropical Botanical Garden in developing responsible long-term stream and watershed management plans for the Onomea area. The portion of the study discussed here includes macrofaunal (gobies, snails and crustaceans) distribution and abundance and a description of physical habitat and water quality conditions during the study period

MACROFAUNA

The native Hawaiian freshwater fish fauna consists of three endemic gobies; *Lentipes concolor* (*'o 'opu alamo 'o*), *Sicyopterus stimpsoni* (*'o 'opu nopili*) and *Stenogobius hawaiiensis* (*'o 'opu naniha*), an indigenous goby; *Awaous guamensis* (*'o 'opu nakea*), and an endemic eleotrid; *Eleotris sandwicensis* (*'o 'opu akupa*). Native crustaceans found in Hawaiian streams include the mountain shrimp *Atyoida bisulcata* (*'opae kuahiwi*) and an estuarine species *Macrobrachium grandimanus* (*'opae 'oeha 'a*). Also present throughout the state is the introduced Tahitian prawn (*Macrobrachium lar*), which was first released in Hawai'i in 1956. Native gastropods found in Hawaiian streams include the limpet-like *Neritina granosa* (*hihiwai*) and the more estuarine *Theodoxus vespertinus* (*hapawai*).

As is typical of freshwater species on oceanic islands, the native gobies, shrimp and snails, as well as the introduced prawn, have an amphidromous life cycle. To complete their life cycle, the animals must migrate between the stream and ocean. Eggs are laid in the stream, the eggs hatch and the larvae wash out to the sea. After spending a larval phase as marine plankton, post-larvae return to a stream where they spend the remainder of their life.

MACROFAUNAL SURVEYS

The initial macrofaunal survey was conducted in January 1997, with subsequent surveys in June 1997, September 1997 (prior to dam removal), October 1997 (following dam removal) and December 1997. Because of the small stream size, both streams were surveyed with a

complete "swim-through" as opposed to the more commonly used quadrat method (Brasher, 1995). To conduct the "swim-through," two observers wearing mask and snorkel swam, or crawled, side by side from the mouth of the stream to approximately 100 meters above the roadway (and diversion structures). All species observed during the survey, and the size of each individual, was recorded.

The June 1997 survey was conducted by Gordon Smith as part of the State Department of Health Rapid Stream Bioassessment program (See Appendix A). This survey included only the area 50 meters above and below the diversion structure on each stream. Onomea Stream began flooding during the September 1997 survey, consequently only the area below the diversion (surveyed prior to the rise in water) was surveyed that day.

Onomea Stream and Alakahi Stream had quite low densities of native gobies, crustaceans and snails, and high densities of introduced prawns. The goby *Lentipes concolor* (*'o'opu alamo'o*) was quite rare, with only one or two individuals observed the entire length of either stream. Likewise, only three individuals of the estuarine goby *Stenogobius hawaiiensis* (*'o'opu naniha*) were observed (in Onomea Stream) throughout the study. The goby *Awaous guamensis* (*'o'opu nakea*) was also uncommon, with usually less than twenty individuals noted in either stream. The estuarine eleotrid *Eleotris sandwicensis* (*'o'opu akupa*) and the goby *Sicyopterus stimpsoni* (*'o'opu nopili*) were more common in both streams.

Although native crustaceans (*Atyoida bisulcata* and the estuarine *Macrobrachium grandimanus*) and snails (*Neritina granosa* and the estuarine *Theodoxus vespertinus*) were observed, they were not common. The introduced prawn *Macrobrachium lar*, on the other hand, was quite abundant, with hundreds of individuals recorded during each survey. A few individuals of the introduced guppy (*Poecilia reticulata*) were observed during the first two surveys, but not subsequently.

Macrobrachium lar was also abundant above the diversion structure on each stream, and few other animals were observed, although juvenile and adult *shrimp (Atyoida bisulcata*) were present upstream of the dam on Alakahi Stream. The diversion structures were relatively small, and did not create a dry stream reach, however, no *Sicyopterus stimpsoni* or *Neritina granosa* were found above either dam. Follow-up surveys may determine whether the dams did provide a barrier to upstream migration of these two species.

Onomea and Alakahi Streams are notable for containing the entire compliment of native stream macrofauna, although at quite low densities. Further investigation into recruitment dynamics (return of larvae to the stream from the ocean) and potential impacts of the aggressive introduced prawn *Macrobrachium lar* on the native species could provide valuable information as to the causes of the low abundance of native macrofauna in the two streams.

MACROFAUNAL SURVEYS ONOMEA STREAM

ABOVE DIVERSION

	SPECIES	SURVEY MONTH				
		Jan-97	Jun-97	Sep-97	Oct-97	Dec-97
FISH	*Kuhlia sandvicensis*			*		
	Eleotris sandwicensis					
	Stenogobius hawaiiensis					
	Awaous guamensis	X				X
	Sicyopterus stimpsoni					
	Lentipes concolor					X
	Poecilia reticulata					
CRUSTACEANS						
	Macrobrachium grandimanus					
	Atyoida bisulcata					
	Macrobrachium lar	X	X		X	X
SNAILS						
	Theodoxus vespertinus					
	Neritina granosa					

*Upper reach not surveyed due to stream flooding

BELOW DIVERSION

	SPECIES	SURVEY MONTH				
		Jan-97	Jun-97	Sep-97	Oct-97	Dec-97
FISH	*Kuhlia sandvicensis*	X	*	X	X	X
	Eleotris sandwicensis	X	*	X	X	X
	Stenogobius hawaiiensis		*		X	X
	Awaous guamensis	X	X	X	X	X
	Sicyopterus stimpsoni	X		X	X	X
	Lentipes concolor	X				X
	Poecilia reticulata	X	X			
CRUSTACEANS						
	Macrobrachium grandimanus		*		X	
	Atyoida bisulcata					X
	Macrobrachium lar	X		X	X	X
SNAILS						
	Theodoxus vespertinus		*	X	X	X
	Neritina granosa	X		X		X

* Survey conducted 50 meters below and above diversion, estuarine species not expected

MACROFAUNAL SURVEYS ALAKAHI STREAM
BELOW DIVERSION

SPECIES	SURVEY MONTH Jan-97	Jun-97	Sep-97	Oct-97	Dec-97
FISH					
Kuhlia sandvicensis	X	*	X	X	X
Eleotris sandwicensis	X	*	X	X	X
Stenogobius hawaiiensis		*			
Awaous guamensis	X	X	X	X	X
Sicyopterus stimpsoni	X		X	X	X
Lentipes concolor				X	
Poecilia reticulata					
CRUSTACEANS					
Macrobrachium grandimanus	X	*	X	X	X
Atyoida bisulcata		X	X	X	X
Macrobrachium lar	X	X	X	X	X
SNAILS					
Theodoxus vespertinus		*	X	X	X
Neritina granosa	X			X	X

* Survey conducted 50 meters below and above diversion, estuarine species not expected

ABOVE DIVERSION

SPECIES	SURVEY MONTH Jan-97	Jun-97	Sep-97	Oct-97	Dec-97
FISH					
Kuhlia sandvicensis					
Eleotris sandwicensis					
Stenogobius hawaiiensis	X		X		X
Awaous guamensis					
Sicyopterus stimpsoni	X		X	X	X
Lentipes concolor					
Poecilia reticulata					
CRUSTACEANS					
Macrobrachium grandimanus		X		X	X
Atyoida bisulcata	X	X		X	X
Macrobrachium lar					
SNAILS					
Theodoxus vespertinus					
Neritina granosa					

PRAWN ABUNDANCE

To estimate the number of introduced prawns (*Macrobrachium lar*) in the lower reaches of Onomea Stream and Alakahi Stream (approximately 200 m^2 area for each stream), prawns were captured and marked in the evening and searched for the following day. During the capture, prawns were collected with dip nets, removed from the stream and marked on the carapace using fingernail polish. The next morning, we swam through the lower reaches of the stream, noting all marked and unmarked prawns that we observed.

A total of 88 *M. lar* were marked in Alakahi Stream on 9 August 1997, with 34 marked prawns recorded in the lower reaches the following day. A total of 103 *M. lar* were marked in Onomea Stream on 5 September 1997, with 33 marked prawns recorded in the lower reaches the following day. Four additional marked prawns were observed further upstream in Onomea Stream, but not included in the abundance estimation.

Calculation of abundance resulted in an estimation of 652 $\pm$ 89 prawns in the lower reaches of Onomea Stream, and 432 $\pm$ 56 prawns in the lower reaches of Alakahi Stream. *M. lar* was the most abundant species recorded during the swim through surveys in both streams, and these estimates of abundance in the lower reaches confirm that very high numbers of M. lar occur in these two streams.

RECRUITMENT

Recruits (post-larval gobies returning from the ocean to the stream) were collected at the mouth of Onomea Stream, with Breder traps on 18 February 1997, and with dip nets on 29 April 1997. Twelve *Awaous guamensis* (mean size 16.4 mm), one *Sicyopterus stimpsoni* (24.5 mm) and two *Stenogobius hawaiiensis* (18 mm and 19 mm) were collected on February 18th. Fifteen *A. guamensis* (mean size 16.2 mm) were collected on April 29th. While *A. guamensis* were the most abundant post-larval gobies collected, *S. stimpsoni* were more abundant as adults.

PHYSICAL AND CHEMICAL PARAMETERS

Physical and chemical parameters were measured periodically throughout the one year study; and before, during and after dam removal on the day (September 16, 1997) that the diversions were removed. Most parameters were measured at two stations on each stream, one below and one above the diversion. At each station temperature was recorded. Flow was measured with a Swoffer meter and top-setting wading rod, and discharge then calculated using standard methods. Total dissolved oxygen was measured with a YSI oxygen meter, turbidity with a LaMotte nephlometer, conductivity with a YSI SCT meter, and pH with an Orion pH meter.

CONDUCTIVITY

ALAKAHI STREAM

STATION	DATE	REPLICATES		
25M	6/10/97	88	87	86
(BELOW	9/16/97	104		
DAM)		122		
DAM REMOVAL (1145 to 1500 hrs)				
		115		
	10/27/97	109	109	109
	12/4/97	89	89	89
80M	6/10/97	88	88	88
(ABOVE	8/12/97	92		
DAM)	9/16/97	80		
DAM REMOVAL (1145-1500 hrs)				
		100		
	10/27/97	107	104	107
	12/4/97	89	89	89

ONOMEA STREAM

STATION	DATE	REPLICATES		
10M	6/10/97	50	50	49
(BELOW	9/16/97	49		
DAM)		53		
		60		
DAM REMOVAL (1145 to 1500 hrs)				
		45		
	10/27/97	59	59	59
	12/4/97	46	46	46
55M	6/10/97	49	49	49
(ABOVE	8/12/97	71		
DAM)	9/16/97	35		
DAM REMOVAL (1145-1500 hrs)				
		43		
	10/27/97	59	59	59
	12/4/97	46	46	46

TURBIDTY (ntu)

ALAKAHI STREAM

STATION	DATE	REPLICATES		
25M	6/10/97	2.05	1.73	2.17
(BELOW	9/16/97	3.10		
DAM)		28.30		
DAM REMOVAL (1145 to 1500 hrs)				
		108.00		
		3.40		
	######	1.07	1.01	1.14
	12/8/97	1.91	1.90	1.93
80M	6/10/97	1.46	1.44	1.30
(ABOVE	8/12/97	0.15		
DAM)	9/16/97	0.40		
DAM REMOVAL (1145-1500 hrs)				
		0.80		
	######	1.06	0.96	1.01
	12/8/97	1.88	1.92	1.89

ONOMEA STREAM

STATION	DATE	REPLICATES		
10M	6/10/97	2.77	3.30	3.02
(BELOW	9/16/97	9.20		
DAM)		9.60		
		8.10		
DAM REMOVAL (1145 to 1500 hrs)				
		4.40		
		3.10		
	######	2.64	2.71	2.69
	12/4/97	2.91	2.87	2.94
	12/8/97	1.57	1.59	1.54
55M	6/10/97	2.76	2.58	2.70
(ABOVE	8/12/97	0.50		
DAM)	9/16/97	3.40		
DAM REMOVAL (1145-1500 hrs)				
		4.60		
	######	2.92	2.87	3.00
	12/4/97	2.75	2.72	2.63
	12/8/97	1.54	1.51	1.49

While both Onomea Stream and Alakahi Stream are small by Hawai'i standards (Hawaii Stream Assessment, 1991), Onomea Stream had a much larger average discharge (4.55 $\pm$ 2.04 cfs) during the study than Alakahi Stream (0.36 $\pm$ 0.23 cfs). Onomea Stream has several deep pools in the reach below the diversion and is also notable for having a large shallow estuary-like pool at the mouth. Alakahi Stream runs into the sea as a narrow boulder-strewn run with a small gravel berm at the mouth.

Average water temperature during the study was the same (25 c) for both streams. Dissolved oxygen concentration was slightly higher in Onomea Stream (8.6 $\pm$ 0.31 mg/l) than in Alakahi Stream (8.1 $\pm$ 0.17 mg/l), although both streams could be considered oxygen-saturated. Oxygen concentrations increased throughout the day in both streams on the day the diversions were removed. This occurred both above and below the dam removal location, and is a natural stream process with increasing sun exposure throughout the day.

Confirming visual observations, measured turbidity levels were consistently higher in Onomea Stream (3.21 + 2.06 ntu) than in Alakahi Stream (1.55 + 0.76 ntu). Onomea Stream was also observed flooding more often than Alakahi Stream during the one year study period. Although both streams became more visually turbid during the actual dam removal, only measurements in Alakahi Stream showed major changes in turbidity; from about 3 ntu prior to dam removal to 108 ntu during actual dam destruction. Several hours later on the same day, turbidity returned to 3 ntu in Alakahi Stream.

Conductivity was higher in Alakahi Stream (96.54 $\pm$ 11.28) than in Onomea Stream (51.28 $\pm$ 7.62) during the study, while pH was similar in both Alakahi (8.13 + 0.75) and Onomea (8.16 + 0.70) Streams. Neither parameter changed very much during the dam removal process.

SUMMARY

A one year study was conducted to evaluate physical, chemical and biological parameters in Onomea Stream and Alakahi Stream in South Hilo, Hawaii. While both Onomea Stream and Alakahi Stream are small by Hawai'i standards, Onomea Stream had a much larger average discharge (4.55 cfs) during the study than Alakahi Stream (0.36 cfs), and tended to flood more frequently. Both streams had quite low densities of native gobies,crustaceans and snails, and high densities of introduced prawns. A mark and recapture study showed there to be approximately 650 adult prawns (*M. lar*) in the lowest reach of Onomea Stream and approximately 430 adult prawns in the lowest reach of Alakahi Stream. Likewise,in the reach above the diversion, prawns accounted for all but a few of the individuals recorded during the surveys. Follow-up surveys may indicate whether removal of the diversions resulted in additional upstream colonization by the native stream macrofauna.

Onomea and Alakahi Streams both contain the entire compliment of native stream macrofauna, although at quite low densities, indicating potential for the establishment of robust populations of native species in these streams. Interestingly, while A.guamensis were the most abundant post-larval gobies collected returning to the stream, S. stimpsoni were more abundant as adults. Further investigation into recruitment dynamics (return of larvae to the stream from the

ocean) and potential impacts of the aggressive introduced prawn Macrobrachium lar on the native species could provide valuable information as to the population dynamics and community structure in the two streams.

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APPENDIX

STREAM BIOASSESSMENT PROGRAM

Onomea & Alakahi Streams

June 10, 1997 Stream Survey Report

Gordon C. Smith
Hawaii Department of Health
Environmental Management Division

BIOLOGICAL ASSESSMENTS OF HAWAIIAN STREAMS

I. Evaluating Aquatic Life Use With an Index of Biotic Integrity

Water quality standards (WQS) are set through a process of defining designated uses of waterbodies and setting water quality criteria which protect those uses. The "support and propagation of aquatic life" is a designated use common to all waterbodies in the state of Hawaii. By maintaining and improving these "aquatic life uses" the requirement for protection of fishable waters set by State law and the Federal Clean Water Act is met.

Water quality criteria have historically been set to reflect physical and chemical attributes of water which may affect aquatic life uses, instead of focusing on aquatic life use attainment directly. For example, criteria for turbidity and nutrients such as nitrogen and phosphorus are set for streams in Hawaii at concentrations that are assumed sufficiently stringent to prevent eutrophication and accumulations of heavy silt loads, two conditions which impair aquatic communities. Direct examination of the number, type and condition of organisms in aquatic systems has, to date, not been incorporated into evaluations of aquatic life use attainment as defined in Hawaii's WQS.

An index of biotic integrity (IBI) may be used to evaluate community-level characteristics of the biota inhabiting aquatic environments. An IBI is based on scoring a number of individual "metrics", each of which represents an aspect of the aquatic community; metrics can reflect absolute or relative number of species, number of individuals, trophic or reproductive guild, or somatic condition. The sum of the individual scores for a set of metrics is the IBI. Determinations regarding the IBI are made relative to a "least-impaired" reference condition on a regional basis.

A pilot program undertaken by the Department of Health Environmental Planning Office has resulted in the development of an IBI for Hawaiian streams (this specialized index is called the Hawaii Stream Bioassessment Index or HSBI). Metric scores primarily reflect presence/absence or relative abundance of native and introduced species. Metrics can be awarded a score of 1, 3 or 5 depending on results of a visual census performed in a 100 meter length of stream (Table 1). The sum of scores of all six metrics yields the HSBI. The maximum HSBI score is 30, a value that would be achieved in a reference condition stream site with 5 or more native amphidromous species, occurrence of both *Lentipes* and *Sycyopterus*, and no more than one introduced species.

Table 1.
Metric scoring criteria for use in the Hawaiian Stream Bioassessment Index.

METRIC[1]	SCORING CRITERIA 5 | 3 | 1		
1. Number of native amphidromous macrofauna[2] (S_{NAM})	5 - 8	3 - 4	2 - 0
2. Percent contribution native taxa (PNT)	60% - 100%	40% - 60%	0% - 40%
3. Sensitive native fish species[3] (SNF)	100% - 75%	50% - 75%	0% - 50%
4.Tolerant introduced fish species[4] (TIF)	0% - 20%	20% - 80%	80% - 100%
5. Community weighted average[5] (CWA)	1 - 3	3 - 9.5	9.5 - 10
6. Number of introduced taxa (NIT)	0 - 1	2 - 3	>3

1. Based on visual census using linear or point count methods.
2. Includes the 5 gobioid fish and larger invertebrates listed in Appendix A.
3. Sensitive = native fish that are most affected by habitat and water quality degradation. These are *Sicyopterus* and *Lentipes*.
4. Tolerant = introduced fish that are most tolerant of habitat and water quality degradation and are widespread throughout state. These are the Poecilids and *Xiphophorus* spp.
5. The formula used to calculate the CWA is: $CWA = \frac{S}{N} \frac{n_i a_i}{\text{-----}}$

where n_i represents the number of individuals in the i^{th} taxon and a_i the weighting value for that taxon (Appendix B).

II. Habitat Condition

Habitat availability is crucial to existence of life in aquatic environments. An integral part of evaluating a biological community is examination of habitat conditions. As a supplement to the HSBI, a habitat characterization is performed. In the habitat evaluation the amount and quality of physical living space is measured at primary, secondary and tertiary levels (Appendix C). Each characteristic is scored, and the sum of all scores provides an index value that, like the HSBI, is compared on a relative basis to a "least-impaired" reference condition. The maximum attainable score for the habitat evaluation is 130, which would represent a "pristine" Hawaiian stream in an *unimpacted* wilderness area.

III. Evaluation of aquatic life use designations

The goal of an assessment of this type is to determine the degree to which a stream supports aquatic life as indicated in HAR 11-54. Using reference conditions derived from 19 sites on 13 streams statewide, a set of guideline values has been calculated for determining quality of habitat as scored by the habitat evaluation. Similarly, guideline values for interpretation of the biological condition represented by the HSBI have been estimated (Table 2).

Table 2.
Guideline values for interpreting attainment
of aquatic life uses in Hawaiian streams.

Habitat (% of reference)	Biological condition (% of reference)
<50% = nonsupport	<25% = impaired
50% - 75% = partial support	25% - 75% = moderately impaired
>75% = supporting	>75% = nonimpaired

ASSESSMENT OF ALAKAHI AND ONOMEA STREAMS

I. Site description

Alakahi and Onomea streams are small, steep streams of the North Hilo district of the Island of Hawaii. According to HAR 11-54 -05.1(c) both streams are considered class 2 inland waters. Designated uses for class 2 waters include: protection and propagation of aquatic life, contact recreation, and agricultural and industrial water supplies (HAR 11-54-03[b]).

Both streams originate in upland areas that until recently were cultivated in sugarcane, these upper watersheds are now fallow, with a ground cover consisting of non-native grasses and volunteer cane. Both of these watercourses are short, rocky and steep. Exposed basaltic bedrock and boulders form most of the stream beds. The flow of Onomea stream is augmented by ditch water that is diverted out of a neighboring watershed. Both streams flow into Onomea Bay, through a dense forest of non-native trees and shrubs that provide a particularly dense overstory throughout the mid- and lower reaches. Both streams flow through the area of Hawaii's worst infestation of *Miconia,* an introduced pestiferous shrub that is known to occlude the growth of other plants by growing rapidly and shading understory emergent plants.

Because of limited access, the 100 meter sites on both Onomea and Alakahi extended above and below the road crossing. Each site also has a concrete low-level diversion dam in the lower third section. Other than a dense overstory of vegetation which included *Miconia*, there were no soil or vegetation disruptions in the vicinity of the Alakahi site. A construction project on the bank of Onomea stream has resulted in significant areas of cleared vegetation and exposed soil for road building and construction access. This activity affected the upper half of the site.

Field surveys were performed on June 10, 1997. Survey conditions were not ideal at either site. Cloudy conditions and light rain hampered observations at the Alakahi site. Higher than normal flow conditions and slightly turbid water reduced visibility for observations at the Onomea site. This condition may have led to reduced efficiency in observing the individuals within the sites.

Both sites were surveyed using a linear swim-through transect through the entire site. Total numbers of observed fish and larger invertebrates were low, with the exception of the introduced prawn *Machrobrachium lar*. Observations indicated that recent recruitment has occurred in Alakahi stream; four of the *A. guamensis* individuals were 40-60 mm total length, and 20 of the *A. bisulcata* were small-sized juveniles.

II. Alakahi results

The following results were obtained from the Alakahi survey:

TAXA			
	M. lar	*A. guamensis*	*A. bisulcata*
Number	118	8	26

These observations lead to metrics scores as follows:

METRIC	Obs. value	Score
1. Number of native amphidromous macrofauna[2] (S_{NAM})	2	1
2. Percent contribution native taxa (PNT)	66%	5
3. Sensitive native fish species[3] (SNF)	0	1
4.Tolerant introduced fish species[4] (TIF)	0	5
5. Community weighted average (CWA)	7.76	3
6. Number of introduced taxa (NIT)	1	5
	TOTAL - HSBI score: 20	

This HSBI score above represents 66% of the reference condition score and represents a "partially impaired" biological condition as indicated by the guideline values of Table 2.

Habitat evaluation scores are similarly summed to give the habitat index value:

Habitat Characteristic	Score
Substrate	13
Embeddedness	16
Velocity-Depth	15
Channel Shape	10
Width-to-depth	11
Pool-to-riffle	12
Soil stability	9
Vegetation disruption	8
Riparian zone	7
TOTAL - Habitat score: 101	

The habitat evaluation score above represents 78% of reference conditions. This result represents "supportive" habitat condition as indicated by the guideline values of Table 2. This value is at the extreme lower end of this range and should be considered borderline.

III. Onomea results

The linear swim-through survey of the Onomea site resulted in the following observations:

	TAXA		
	M. lar	*A. guamensis*	Poecilidae
Number	140	1	1

These observations lead to metrics scores as follows:

METRIC	Obs. value	Score
1. Number of native amphidromous macrofauna[2] (S_{NAM})	1	1
2. Percent contribution native taxa (PNT)	33%	1
3. Sensitive native fish species[3] (SNF)	0	1
4.Tolerant introduced fish species[4] (TIF)	1	3
5. Community weighted average (CWA)	8.97	3
6. Number of introduced taxa (NIT)	2	3
	TOTAL - HSBI score: 12	

This HSBI score above represents 40% of the reference condition score and represents a "partially impaired" biological condition as indicated by the guideline values of Table 2.

Habitat evaluation scores for Onomea stream provided the following habitat index value:

Habitat Characteristic	Score
Substrate	13
Embeddedness	15
Velocity-Depth	13
Channel Shape	12
Width-to-depth	13
Pool-to-riffle	13
Soil stability	5
Vegetation disruption	6
Riparian zone	5
TOTAL - Habitat score: 95	

The habitat evaluation score above represents 73% of reference conditions. This result represents "partially supportive" habitat condition as indicated by the guideline values of Table 2.

IV. Discussion

In general, very few native aquatic organisms were seen at either site during the survey. This fact alone leads to the conclusion that aquatic life uses are not adequately supported, and that some level of degradation affects these streams. Total numbers of organisms were consistent with, or slightly lower than, streams of similar size located in areas of rural housing and agricultural activity. Waiomao stream in urban Honolulu and lower Waianu stream in rural windward Oahu scored similarly, and have comparable representation (in diversity and abundance) of native species.

Note that the calculations of metrics scores are intentionally not based on *total* numbers of organisms but on the *relative* abundance and representation of specific taxa. This gives an index value that represents community-level organization at the survey site, but can be misleading in that depauperate sites such as these can score higher than a stream with larger absolute numbers of native species. If total numbers per unit stream length or unit area are required, then a different survey protocol is needed to give statistically meaningful results. For example, a site on Waiahole stream (site Waiahole2 in Figure 1, below) of windward Oahu has higher absolute numbers of native species (also mostly *A. guamensis*), yet scores slightly lower than either Alakahi or Onomea; primarily because of higher diversity and abundance of introduced species.

Figure 1.

HSBI and Habitat Comparisons for Hawaiian Streams

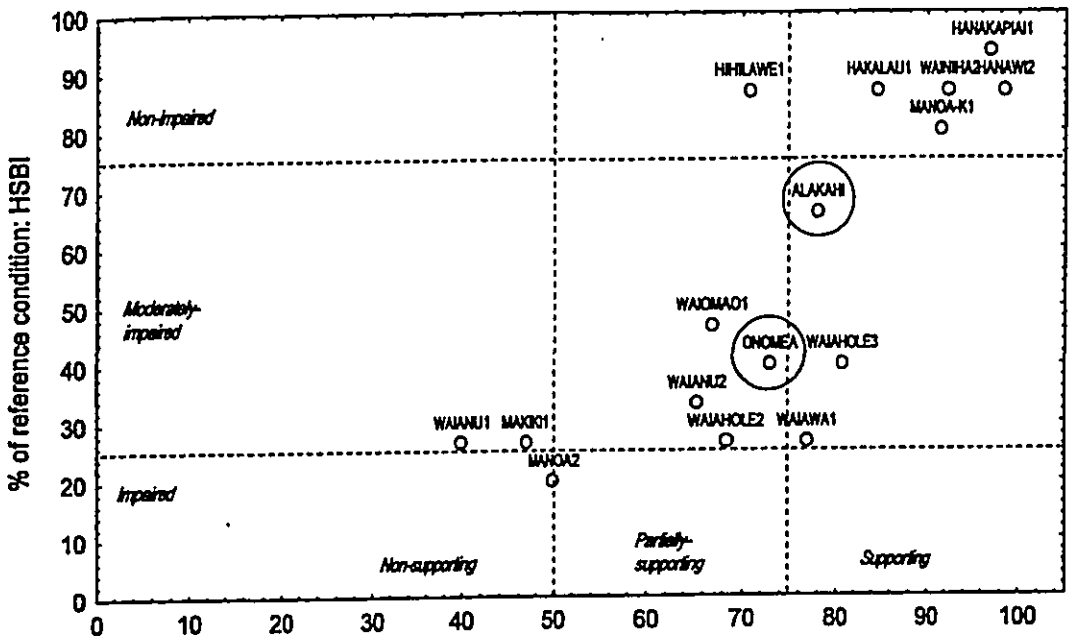

Figure 1 is a graphical representation of the results of the surveys and shows the HSBI and habitat evaluation scores relative to other surveyed streams in the State. Scores for both streams are indicative of "moderately impaired" aquatic life use and habitat that is "partially supportive" of the needs and requirements of the organisms that make up the community of fish and larger invertebrates of Hawaiian streams. Alakahi stream had a higher HSBI value primarily because native species made up two out of three of the species recorded in the survey. Alakahi habitat scores were higher because, other than the existing road, there were no recent disruptions to vegetation or soils from construction clearing or agriculture in the vicinity of the site. This habitat score requires some interpretation because of the predominance of non-native forest canopy species. Dense shading of the forest floor and stream bed leads to reduced understory vegetation and erosion and siltation potential in the stream. Also, reduced insolation of the stream itself decreases instream primary production which results in a diminished food supply for benthic organisms, and reduced food supply for facultative grazers such as *A. bisulcata* and *S. stimpsoni* [1] . Only a single *A. guamensis* was seen in Onomea stream, and the HSBI score was

[1] Refinement of these assessment methods scheduled for 1998 will take these

correspondingly lower. Habitat disruption was obvious and affected the upper half of the site; habitat evaluation scores were lower at the Onomea site.

The goal of completely protecting aquatic life uses in Hawaiian streams is only fully accomplished in streams located in the more remote areas of the State. Streams that partially attain this goal suffer from a range of difficult-to-address problems that include watershed degradation due to agriculture and housing, non-native species introductions in the riparian areas and in the stream itself, and diversion of instream flows. Alakahi and Onomea streams are typical of streams that are affected by these problems, and as a result do not fully support the designated uses defined in the State's Water Quality Standards.

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watershed and landscape-level factors into account in revising the habitat evaluation scoring regime.

Appendix A.

Larger native stream fauna of Hawaii.			
Scientific name	Hawaiian name	Biogeographic status	Type of organism
Awaous guamensis	O'opu nakea	indigenous	Freshwater fish (family Gobiidae)
Lentipes concolor	O'opu alamo'o	endemic	Freshwater fish (family Gobiidae)
Stenogobius hawaiiensis	O'opu naniha	endemic	Freshwater fish (family Gobiidae)
Sicyopterus stimpsoni	O'opu nopili	endemic	Freshwater fish (family Gobiidae)
Eleotris sandwicensis	O'opu akupa	endemic	Freshwater fish (family Eleotridae)
Atyoida bisulcata	Opae kala'ole	endemic	Crustacean Freshwater shrimp
Macrobrachium grandimanus	Opae 'oeh'a	endemic	Crustacean Freshwater prawn
Neritina granosa	Hihiwai	endemic	Mollusk Freshwater snail

Appendix B.

The Community Weighted Average (CWA) is a numerical expression that reflects the relative sensitivity of various taxa to water quality and habitat degradation and the numbers of each taxa in a sample and is calculated as follows:

$$CWA = S \frac{n_i a_i}{N}$$

Where n_i represents the number of individuals in the i^{th} taxon, a_i the weighting value for that taxon and N the total number of individuals in the sample.

Weighting values of larger Hawaiian stream organisms used in calculating the CWA.	
SPECIES	Weighting value
Lentipes concolor	1
Sicyopterus stimpsoni	1
Neritina granosa	2
Atyoida bisulcata	3
Macrobrachium grandimanus	4
Awaous guamensis	5
Stenogobius hawaiiensis	6
Eleotris sandwicensis	7
Introduced species:	
Group 1[1]	10
Group 2[2]	9

1. Introduced species: Group 1 includes taxa that are profligate, predaceous, or cause physical changes in the habitat: for example the Poecilidae, *Microperus* sp., and amorheaded catfish.
2. Introduced species: Group 2 includes introduced species that exhibit fewer direct effects in the stream environment, for example *Macrobrachium lar.*

Appendix C. Habitat Assessment Data Sheet

Primary Habitat Characteristics — Possible score of 0 - 20.

SUBSTRATE

Sand/sediment rare and localized. 0-9% of wetted substrate	Sand/sediment uncommon. 10-19% of wetted substrate.	Sand/sediments widespread. 20-49% of wetted substrate.	Sand/sediments widespread. 50-100% of wetted substrate
SCORE (16-20)	(11-15)	(6-10)	(0-6)

EMBEDDEDNESS

Large interstitial spaces having high volume water flow.	Interstitial spaces limited in size and extent. 25-50% embedded.	Interstitial spaces small and uncommon. 50-75% embedded.	Interstitial spaces rare, >75% embedded.
SCORE (16-20)	(11-15)	(6-10)	(0-6)

VELOCITY-DEPTH

Fast deep, fast shallow, slow deep, slow shallow — all flows present.	3 of the 4 conditions present.	2 of the 4 conditions present.	One dominant velocity-depth condition.
SCORE (16-20)	(11-15)	(6-10)	(0-6)

Secondary Habitat Characteristics — Possible score of 0 - 15.

CHANNEL SHAPE

Deep U-shaped.	Shallow U-shaped.	Broad, flat.	Man-made channel.
SCORE (12-15)	(8-11)	(4-7)	(0-3)

WIDTH TO DEPTH RATIO

Less than 1:8.	Ratio of 1:8 to 1:13.	Ratio of 1:13 to 1:23.	Greater than 1:23.
SCORE (12-15)	(8-11)	(4-7).	(0-3)

POOL TO RIFFLE RATIO

Frequent alternation of habitat types. Ratio of 1:1 to 1:2.	Some alteration of habitat types. Ratios of 1:2 to 1.5.	Habitat types rarely alternate. Ratios of 1:5 to 1:20.	Homogeneous habitat. Ratio <1:20.
SCORE (12-15)	(8-11)	(4-7)	(0-3)

Tertiary Habitat Characteristics — Possible score of 0 - 10.

SOIL STABILITY

Stable, no erosion evident.	Little erosion, older eroded areas recovered.	Eroded areas moderate in size and extent.	Unstable, many eroded areas.
SCORE (9-10)	(6-8)	(3-5)	(0-2)

VEGETATION

Vegetation disruption not evident, all "potential plant biomass" intact.	Vegetation disruption has occurred in small localized areas, most "potential plant biomass" remains.	Disruption obvious, widespread, patches of bare soil: little "potential plant biomass" remains	Plant removal severe, mostly bare soil or closely cropped plants; lawns, hedges, crops.
SCORE (9-10)	(6-8)	(3-5)	(0-2)

RIPARIAN ZONE

Riparian zone >4 times stream width, no human impacts.	Riparian zone 2-4 times stream width, minimal human impacts	Riparian zone 1 times stream width, widespread human impacts	Little or no riparian zone (pavement, lawn, cement channel lining, etc)
SCORE (9-10)	(6-8)	(3-5)	(0-2)

TOTAL SCORE:

The Orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas* (Odonata: Coenagrionidae): Clarifying the Current Range of a Threatened Species[1]

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Introduction

The Orangeblack Hawaiian Damselfly, *Megalagrion xanthomelas* Selys-Longchamps, formerly occurred in lowland aquatic habitats throughout all the high Hawaiian Islands. Although common at the turn of the century, the species began to experience a progressive decline after World War II, and by the early 1990s had not been seen on Oahu for over 20 years. This fact, coupled with the extensive alteration of lowland habitats in which the species formerly bred, led Polhemus (1993) to conclude that the species was probably extirpated on Oahu when he reviewed the conservation status of *Megalagrion* species for the U. S. Fish and Wildlife Service (USFWS). Based on this assessment, plus the apparent extirpation of the species on Kauai and Maui as well, USFWS (1994) proposed that *M. xanthomelas* be listed as a Threatened species and given protection under the Endangered Species Act.

Given this, it was of great interest when a remnant population of *M. xanthomelas* was discovered in the course of an environmental survey conducted by personnel from the Hawaii Biological Survey in March 1994 at the Tripler Army Medical Center (TAMC), on the outskirts of Honolulu. This population, so far as is known, is the last remaining colony of *M. xanthomelas* on Oahu, and thus a priority target for conservation efforts. The existence of the population was noted in a report to the R.W. Towill Corporation of Honolulu (Evenhuis & Cowie 1994); this report also concluded that the insects were confined to a small gully near the greenhouse at the lower end of the TAMC site, in an area that had the potential for being impacted by proposed construction activities further upslope. It was recommended that in order to ensure the continued survival of the TAMC *M. xanthomelas* colony the population should be relocated to a nearby site that would not be subject to construction impacts or other activities taking place on the TAMC grounds, a task that has recently been accomplished through the construction of an artificial refugium

In order to properly design the refugium for the TAMC population, it was necessary to conduct a detailed investigation of the biology of *M. xanthomelas*, which was poorly known at the time. This involved both detailed studies at TAMC (to be reported in a separate publication), and investigations at sites on other islands where populations of *M. xanthomelas* were still known to persist. This report details the results of those surveys, providing a statewide conservation assessment of this increasingly rare species.

Taxonomy and Historic Distribution of *Megalagrion xanthomelas*

Megalagrion xanthomelas was described by Selys-Longchamps (1876) based on specimens collected by G.F. Matthew of the Royal Navy, and labelled "Sandwich Islands", with no specific island within the group noted on the labels. The location of Selys-Longchamps' types is not currently known, although they may be in the Koninklijk

1. Contribution No. 1996-003 to the Hawaii Biological Survey.

Belgisch Instituut voor Natuurwetenschappen, in Brussels. The species has not been confused with others since its original description, thus its taxonomic history is relatively simple and devoid of synonyms.

The original distribution of *M. xanthomelas* within the Hawaiian Islands is a matter of some speculation. It seems unlikely that the species ever inhabited the small, dry island of Kahoolawe, and its presence on Kauai is open to question, although a single specimen is present from nearby Niihau (see below). Perkins (1899) stated that *M. xanthomelas* "Probably occurs all over the islands", despite the fact that he lacked any collections from Kauai and Lanai. Kennedy (1917), probably following Perkins' statement, listed *M. xanthomelas* from Oahu, Molokai, Maui, Hawaii, Kauai and Lanai, even though once again there were apparently no specimens at hand supporting the latter 2 records. It was only in 1993 that specimens were finally captured on Lanai (Polhemus 1993); and to date the species has never been taken on Kpuai.

The ecology of *M. xanthomelas* was discussed anecdotally by Williams (1936), who also illustrated the immatures. They appear to have formerly bred in impounded sections of lowland streams, and in both natural and artificial ponds. The ability of this species to exploit artificial habitats was noted by Perkins (1913), who observed that *M. xanthomelas* was:

> "a common insect in Honolulu gardens and in lowland districts generally, not usually partial to the mountains, though in the Kona district of Hawaii it is common about stagnant pools up to an elevation of about 3000 feet. It is very numerous under conditions changed from the natural; perhaps it now finds more numerous breeding places, and a more abundant prey in the numerous insects that have been introduced by man in the region it frequents."

Williams (1936) also noted that *xanthomelas* bred abundantly in sugar plantation reservoirs at Waianae. Zimmerman (1948), by contrast, remarked that the introduction of *Gambusia* topminnows "has changed the lowland situation considerably in recent years, however, and the species is much less abundant than formerly."

The decline in populations of *M. xanthomelas* noted by Zimmerman in the years after World War II has continued to the present day. The species is now apparently extirpated on Maui, with no records from that island for the last hundred years, and reduced to single known population on Oahu (at TAMC). Molokai is known to support 4 populations, and the species is abundant in artifical golf course ponds on Lanai, although elsewhere on that island it retains only a tenuous foothold in small remnants of its former natural habitat. Only on Hawaii Island is the species still truly widespread, being commonly found in the coastal wetlands of the Puna, Kau and Kona districts.

In the sections below, the current distribution of *M. xanthomelas* is discussed on an island by island basis. The terminology used to describe aquatic ecosystems follows Polhemus *et al.* (1992).

Niihau

A single specimen of *M. xanthomelas* is in the Bishop Museum (BPBM) bearing a Niihau label, collected by L.D. Tuthill on 16 August 1947. No specific locality is given, but the specimen was probably collected along the margin of Halulu Lake, a permanent mixohaline pond fed by basal spring outflows, or from one of the perched springs that occur at Kaali and in Waiokanaio Gulch.

Kauai

Although *M. xanthomelas* was listed as occurring on Kauai by Kennedy (1917), there are no extant specimens from this island. The presence of the species on Niihau and Oahu, however, makes it virtually certain that it once occurred on intervening Kauai as well, even during historic times. The extensive alteration of basal spring wetlands on this island, particularly those formerly existing on the Mana plain near the present town of Kekaha (which were filled and converted to sugarcane cultivation beginning in the 1920s), appears to have led to the local extirpation of *M. xanthomelas* on Kauai. An extensive search by John Maciolek of the USFWS in the late 1970s failed to uncover any evidence of this species, and subsequent damselfly surveys on the island have been similarly unsuccessful in locating any populations.

Oahu

Tripler Army Medical Center

The present and historic distribution of *M. xanthomelas* on Oahu is summarized in Figure 1. As noted in the introduction, only a single population of this species is known to remain on the island, at the Tripler Army Medical Center (TAMC) on the outskirts of Honolulu. This population occupies a small gully shaded by koa haole (*Leucaena leucocephala*), with a bedrock channel that in this reach forces the base flow to the surface, creating a series of small pools connected by short, shallow runs. The flow into this reach originates from a 48-inch concrete pipe that drains the area around the main hospital buildings upslope, and disappears downslope into a similar culvert, making the Tripler habitat a small island of relatively natural stream channel within a sea of surrounding development. The survival of *M. xanthomelas* at this site appears to have been paradoxically favored due to the presence of the culverts, which have acted as filters to the introduced fishes that are abundant in the lower section of Moanalua Stream into which the Tripler gully eventually drains.

The *M. xanthomelas* population at TAMC appears to be a remnant of much larger and more continuous populations that formerly occupied the wetlands along the inner margin of Pearl Harbor. Five large basal springs previously emerged from the Koolau Aquifer in this area, these being from east to west the Kalauao, Waiau, Waimano, Waiawa and Waikele springs. The combined discharge of these springs in 1932 was over 80 million gallons a day (Stearns & Vaksvik, 1935), and their outflows formed extensive limnetic and mixohaline wetlands. The above authors noted that these springs issued forth in low, swampy areas along the margin of Pearl Harbor and were affected by tides. Similar types of habitats on Hawaii island currently support large populations of *M. xanthomelas*, and the former presence of this species in the Pearl Harbor area is confirmed by specimens in BPBM and the University of Hawaii.

A search was made of these Pearl Harbor springs for *M. xanthomelas* during damselfly conservation status surveys funded by USFWS, and the results are germane to the present study, since they indicate the absence of other *M. xanthomelas* populations in proximity to TAMC. The closest of the springs to TAMC is the Kalauao Spring, which now forms a watercress farm lying between the Kamehameha Highway and the Pearlridge shopping mall. This spring has been extensively modified by watercress cultivation, and contains large numbers of introduced fish and prawns. A search for *M. xanthomelas* here on several occasions during 1994 and 1995 proved fruitless. The Waiau Spring lies immediately upslope of the Kamehameha Highway and behind a Zippy's restaurant. It is also given over to watercress cultivation, and contains numerous introduced fish species. The Waimano Spring formerly emerged at the site now occupied by the Waiau electrical generating station, built in 1945, which exploits the spring's water for cooling. The Waiawa Spring lies below a bluff occupied by the Leeward Community College, in a degraded area containing the Pearl City Peninsula landfill, a highly contaminated EPA Superfund site; it too supports watercress production, and forms an extensive wetland on its seaward side that has yet to be completely surveyed. The Waikele Springs emerge from the east bank of Waikele Stream upstream from the H-1 freeway bridge; these springs are partially diverted by the Oahu Sugar Company, although significant outflows still emerge, providing the majority of base flow in the terminal reach of Waikele Stream. This area was intensively surveyed by Englund (1993), who found high densities of tilapia, *Rana catesbeiana*, and other introduced aquatic vertebrates, but no indication of *M. xanthomelas*. Based on current knowledge, it thus appears that all the basal spring wetlands in the Pearl Harbor area that formerly could have supported *M. xanthomelas* are now physically altered or biologically degraded to the point that they no longer harbor this species. Examination of *M. xanthomelas* specimens in BPBM shows that the last date of collection for this species at Waipahu was in 1925, although a specimen was taken at Pearl City as late as 1977.

Basal spring wetlands similar to those that occurring at Pearl Harbor are also present on the north shore of Oahu to the east of Haleiwa, near the mouth of the Anahulu River. One of these wetlands, surrounding Emerson Spring, is still relatively intact, although it is now traversed by the recently constructed Haleiwa Bypass highway project. An investigation of these wetland systems by Adam Asquith of the USFWS in early 1995 found them to be dominated by alien aquatic species, and to lack populations of *M. xanthomelas*, although specimens taken at Waialua in 1892 are present in BPBM.

Recent surveys thus indicate that *M. xanthomelas* has been extirpated from suitable lowland habitats throughout Oahu, and reinforce the view of the Tripler population as an isolated remnant that has survived through fortuitous circumstances. Since some of the basal spring wetlands formerly occupied by this species still exist, it might be possible in the future to reintroduce this species to suitably managed sites in the Pearl Harbor and North Shore areas, provided that the Tripler population can be maintained in the interim.

Molokai

Pelekunu Valley

Pelekunu Stream is a swift, rocky, perennial stream that begins as a set of plunging streamlets at elevations near 120 m on the sheer northern face of the Molokai Crest. The catchment takes the form of a giant bowl, ringed by peaks including Kuunuohua, Olokui and Kamakou, the latter at 1515 m being the highest point on Molokai. The headwater reaches are nearly vertical, with the stream profile making an abrupt transition to a more moderate gradient at ca. 915 m elevation, which is interpreted as the head of the midreach. From this elevation downstream to the mouth the channel exhibits a moderate but continuous gradient, with numerous riffles and small cascades, and thus retains a midreach character completely to its seaward terminus.

The extreme lower section of Pelekunu Valley consists of a vegetated debris fan, laced by various stream channels that are continually cut off and reoccupied. These aban-

doned channels in many cases contain pools with weak flow that are fed by seepage through the pore spaces in the coarse surrounding alluvium. At the mouth of the stream the debris fan forms a transverse barrier of water-rounded rocks and cobbles, behind which the stream pools to form a small pond before entering the sea via a small rapid. The size of the terminal pond varies according to spates and other stream fluctuations, and at certain times of year a black sand beach is also exposed seaward of the cobble bar that impounds it.

Further upstream at the head of the debris fan the bed narrows and vertical walls of coarse volcanic conglomerate occasionally confine the channel. The basic channel substrate throughout this terminal section consists of rounded cobbles averaging 20–40 cm diameter, alternating with beds of coarse gravel. Except for the large pool at the mouth, the stream profile is composed primarily of erosional zones formed by rapids and riffles. In the first kilometer upstream from the mouth numerous streamlets and rheocrenes enter from the east bank off the steep flanking wall of the Olokui massif, forming swampy areas at the base of the eastern valley wall. To the west of the stream mouth is an extensive complex of abandoned taro fields, now dry and heavily overgrown by introduced grasses.

During an initial visit to lower Pelekunu Valley in 1991, the author captured individuals of *M. xanthomelas* along the margins of the terminal pond formed behind the cobble bar at the stream terminus (Polhemus 1991). This bar was high enough and steep enough that the waves did not overtop it, and thus retained a limentic character despite its proximity to the sea. The adults observed here did not range far from the pond, flying low and perching amid vegetation on the stream margins which offered protection from the sea breeze, and since the species was not encountered elsewhere in the lower valley it was assumed that this terminal pond was the breeding site.

This area was revisited in late August of 1995 and showed a number of changes from its aspect in 1991. The alluvial delta bordering the terminal pond was now heavily overgrown with tall stands of Job's tears (*Coix lacryma-jobi*), and the riparian vegetation further up the valley was also much denser. This revegetation appears to indicate recovery from a major flood that took place immediately prior to the initial 1991 survey. The stream channel itself also exhibited a different configuration, splitting into a D-shaped loop just before its seaward terminus. The previously ponded section now occupied a small area along the outside curve of the D near the point where this side branch rejoined the main channel. The pond, which in its present configuration could more properly be considered a deep, flowing pool, was bordered along its seaward side by the terminal cobble bar covered with *honohono* (*Commelina diffusa*), along its eastern side by a steep bedrock face, and along its remaining margins by cobble bars overgrown with Job's tears and Guinea grass (*Panicum maximum*). The pond was measured and found to be 11 m in length and 9.5 m in width, with an inflow width of 5.3 m. The maximum depth of the pond was 1.4 m, and the depth at the inflow was 0.5 m. The substrate of the pond consisted of stream-rounded rocks and cobbles sitting on coarse, dark gravel. The water chemistry of this site is summarized in Table 1.

Megalagrion xanthomelas was found once again at the mouth of Pelekunu Valley during the 1995 survey, but only in a small area along the seaward margin of the reduced terminal pond. At least 4 males were observed perching amid marginal vegetation and making short forays over the open water; no females were seen. A detailed search was made of the leaves of the *honohono* that bordered the pond but no oviposition scars were found, although tissues of this plant are known to be a favored oviposition sites for *M. xanthomelas* at TAMC. Other Odonata co-occurring with *M. xanthomelas* at the terminal pond included the introduced damselfly *Ischnura ramburii* (Selys-Longchamps), which was not seen during the 1991 surveys and may be a recent invader in the valley, and the indigenous dragonflies *Anax junius* (Drury) and *Pantala flavescens* (Fabricius).

Of particular note at Pelekunu was the short time duration of *M. xanthomelas* activity during the day. When the survey team arrived at 0900, the weather was clearing after a brief rain shower and the sun was just rising above the rim of the Olokui massif. Although fair and sunny conditions prevailed for the next several hours after this, no *M. xanthomelas* were observed. In the absence of any activity, surveys were made a short distance up the main stream to see if populations might be present there, but none were found, although 3 other *Megalagrion* species, *M. pacificum* McLachlan, *M. blackburni* McLachlan and *M. hawaiiense (McLachlan)*, were observed. The survey party returned to the pond area at ca. 1130 and at this point found adult *M. xanthomelas* to be active, allowing the capture of several specimens. By 1230, a brief shower passed over and activity ceased. Although the remainder of the day was characterized by alternating periods of sun and light showers, no additional *M. xanthomelas* were observed. At this site the total duration activity on the day that surveys were made thus appeared to be ca. 1 h during midday when the valley received its most direct sunlight. This preference for high light conditions corresponds to similar observations made at the Koele Lodge on Lanai (see following section).

Waikolu Stream

Waikolu Stream is a swift, rocky perennial stream occupying an elongate, sheer-sided valley on the northern, or windward, side of eastern Molokai. As in nearby Pelekunu Valley, the Waikolu drainage begins with a steep headwall section dropping rapidly from an encircling rim at ca. 1067 m elevation to the beginning of the midreach at ca. 305 m elevation. This midreach section continues for several km to the stream mouth, following a moderate gradient with numerous small waterfalls and rapids, with the stream entering the sea across a steeply sloping cobble bar. The stream profile throughout the midreach is thus composed primarily of erosional zones, along with a few deep pools found primarily below old water diversion structures, and in the area immediately behind the cobble bar at the stream terminus. The basic channel substrate throughout the mid- and terminal reaches consists of large stream-rounded boulders averaging 1–2 m in diameter, alternating with beds of cobbles and coarse gravel. The stream is shaded in its upper reaches by a closed canopy forest of kukui and guava, but becomes progressively more open as one proceeds downstream. Numerous small tributary rivulets and rheocrenes enter along the midreach, particularly in the area immediately below the pumping station. These spring fed ecosystems provide stable aquatic habitats that are not subject to the sudden and unpredictable variations in discharge rate that characterize the main stream, and thus support diverse aquatic insect communities including some taxa not commonly seen along the main channel. Water temperatures in along the main channel sampled range from 18 °C at 180 m to 21 °C at 80 m, while the water temperature in the spring fed tributaries is 19 °C (Polhemus 1992).

Individuals of *M. xanthomelas* were observed by Adam Asquith along the terminal reach of Waikolu Stream at midday on 19 July 1995. The insects were not abundant, and

flew along the margins of five slow, shallow stream pools lying behind the terminal bar. In general aspect this habitat is thus very similar to Pelekunu.

Palaau Wetland

An extensive basal spring wetland is present at Palaau, 3 km east of Kaunakakai on the southern coast of central Molokai (Fig. 2). At least 6 individual spring outflows of varying sizes are present in this area, many being marked by stands of bulrushes (*Schoenoplectus* sp.), bordered peripherally by expanses of pickleweed (*Batis maritima*), and others emerging along the margins of shallow coastal basins to form large, horizontally stratified mixohaline ponds, most notably the Kaluaapuhi Pond. Most of the larger springs that emerge above sea level have been boxed, although their outflows still reach the ponds, and water from others is being used to supply an expanding series of aquaculture projects, and for cooling and steam generation at the local power plant. The vegetation of the area is highly altered from its original state, being a kiawe (*Prosopis pallida*) savannah along the inland margins, and bearing a thick band of mangroves seaward, the latter having become established after World War II. A more complete vegetative description of this ecosystem type may be found in Wagner *et al.* (1990). Although the Palnau wetland is still partially intact, the continued spread of aquaculture facilities, which are being actively promoted and funded by the County of Maui, will likely alter this area in the near future, both by reconfiguring the mixohaline pools and marshes, and by diverting the spring waters upon which these systems depend.

Megalagrion xanthomelas was present here along the along the inland margins of the wetland, in company with 2 introduced damselfly species, *Ischnura ramburi* and *Ischnura posita*, and 2 larger dragonfly species, *Ariax junius* and *Orthemis ferruginea*. Individuals of *M. xanthomelas* were observed along the back edge of Kaluaapuhi Pond, in the nearby mangroves along a flooded trail, and emerging as tenerals from small water pockets at the base of an isolated *Schoenoplectus* clump. Measured salinities in Kaluaapuhi Pond varied from 2 ppt at a small spring inflow to 3 ppt in middle of the pond away from this inlet. Stearns & Macdonald (1947) noted that the entire basal lens underlying west and central Molokai is brackish, thus all basal springs in this area are saline to some degree. The fact that *M. xanthomelas* is breeding in the Palaau wetland, which is supplied by such brackish springs, clearly indicates that the species can tolerate salt concentrations of at least 2 ppt.

This conclusion was reinforced by the discovery of *M. xanthomelas* at a small pond adjacent to the Molokai Sea Farms aquaculture facility at western end of the Palaau wetland complex. This pond occupied an elongate, steep sided basin bordered by pickleweed (*Batis maritima*) and other introduced weeds. The waters of the pond were heavily covered with a layer of duckweed (*Lemna aequinoctialis*), which was maintained by the aquaculture farm as a means of deterring algal growth. The steep sides and elongate form of the basin suggest that it is an artificial modification of a former spring outflow.

Megalagrion xanthomelas was present at this small pond, in association with the same damselfly and dragonfly species seen at Kaluaapuhi pond, but did not occur at the adjacent aquaculture ponds, which lacked floating or marginal vegetation. Individual males were seen perching on sticks and weeds that projected over the water, and a tandem pair was observed ovipositing on the thick duckweed mat. The salinity of the water in this pond was taken and found to be 2 ppt, the same as that of the springs at Kaluaapuhi Pond

(the water chemistry of these sites is summarized in Table 1). This once again clearly demonstrates that *M. xanthomelas* can breed in mildly saline waters.

Kauhako Lake

A single immature specimen of *M. xanthomelas* (which was reared to adulthood at BPBM to confirm its identity) was taken by Dr. Robert Kinzie of the University of Hawaii in late March 1995 along the margins of Kauhako Lake, lying in Puu Uao crater on the Kalaupapa Peninsula of northern Molokai. The salinity of the lake is 15 ppt (R. Kinzie, pers. comm.), although freshwater inflows presumably enter at certain points due to percolation through the volcanic cone, creating a system reminiscent of a very large anchialine pool. The lake is over 250 m deep (Maciolek 1982), and its steep, rocky margins lack emergent aquatic vegetation, although they are heavily shaded in some areas by overhanging tree limbs. No adults were seen at the time the immature was collected.

Table 1: Summary of water chemistry and other physical data for sampling sites on Molokai

Site	Soil pH (2/site)		Water pH (2/site)		Air Temp. (°C)	Soil Temp. (°C)	Water Temp. (°C)	Salinity (ppt)
Palaau:								
Kaluaapuhi	—	—	7.2[1]	7.2[1]	—	—	24.5	2.0[1]
			7.1[2]	7.1[2]				3.0[2]
Palaau:								
Molokai Sea Farms Pond	—	—	6.6	6.6	—	—	31.0	2.0
Pelekunu Val. breeding site	—	—	8.2	8.3	—	—	23.0	0.0

[1] Inlet; [2] boat

The distributions of the Molokai populations discussed above are summarized in Figure 2.

Lanai

Koele Lodge

One of the largest populations of *Megalagrion xanthomelas* outside of Hawaii island occurs in a set of ornamental streams and pools at the Koele Lodge on upland Lanai. These habitats, lying at 580 m above sea level, are also the highest elevations from which the species has been recorded in this century. The existence of this population remained undetected until 1993, although the species presumably occupied the ranch pond that was constructed at this site in the late 1800s. The fact that *M. xanthomelas* has been able to colonize an artificial habitat that was constructed within the last 5 years with no consideration to damselflies whatsoever had an important bearing on the situation at TAMC, since it indicated that construction of similar habitats at TAMC might be sufficient to mit-

igate the present threats to the species at this latter site.

The resort complex at Koele, consisting of The Lodge at Koele and The Experience at Koele golf course (referred to subsequently as the Koele Lodge) was constructed in 1990 on the site on the former Koele ranch, at an elevation of 580 m. The development includes ten separate aquatic features, including a large reflecting pool and ornamental stream complex behind the lodge building itself, a putting course nearby with several small ornamental streams, and 8 large ponds scattered around the golf course to serve as water hazards. All of these individual habitats were surveyed, and their water chemistries are summarized in Table 2. For purposes of this study the reflecting pool and inflow stream behind the lodge building were treated as a single aquatic feature, as were the two large ponds at Holes 8 and 9 that are connected by a cascading ornamental stream. Several of these water features are also fed by shared recirculating water systems. Most notable among these are the ponds at Holes 4 and 18, which are widely separated topographically and elevationally (Hole 4 lies at 610 m, Hole 18 at 580 m), but connected hydraulically. Such connections would allow potential transfer of *M. xanthomelas* eggs and immatures from one site to the other. All the water features on the golf course are internally recirculating with the exception of the pond at Hole 17. The pond and streams behind the lodge, Holes 4, 8–9, and 18, and the putting green streams occupy sheltered locations at the base of Lanaihale mountain and are surrounded by tall stands of *Araucaria* and other introduced trees. By contrast, the ponds at Holes 12, 15, 16 and 17 are more exposed to the wind and lack shelter from either topography or trees.

The large pond and its associated inflow streams behind the lodge building, referred to subsequently as the Lodge Pond, has a capacity of 3.5 million gallons, and is not currently subjected to any water treatment protocol. The pond is equipped with a downflow biofilter system, but this has never been used in the 6 years since its emplacement due to technical problems. A high rate sand filter is also installed, but like the biofilter is not currently in use. Instead, occasional treatments of potassium permanganate at 5 ppm concentrations are applied to retard the growth of algae. The pond occupies the site of a previous storage reservoir used by the former Koele Ranch to water cattle, indicating that an artificial aquatic feature has been continuously present at this site for over a century.

The recirculating inflow stream feeding the Lodge Pond originates in a small lily pond upslope from the lodge. This pond occupies a roughly circular basin approximately 4.5 m in diameter and 1 m deep. The surface is covered with numerous floating lily pads, and the western margins are composed of set rock walls bearing a growth of ferns, whose roots hang into the water. This pond previously received applications of Aqua Shade to retard algal growth, but this practice has been discontinued for the last 2.5 years.

The several small streams present on the putting green, immediately east of the lodge building, are swift and unshaded, originating in small ponds lined with ornamental rock walls. They are lined by plantings of exotic flowering plants, and receive an application of Aqua Shade once a month to eliminate algae.

None of the other water features on the golf course are currently subjected to filtration or chemical treatments. Carp were present in the Lodge Pond and at Hole 12, guppies were seen at Holes 12 and 15, and apple snails were present at Hole 15. Apart from this, and the exotic Odonata noted in Table 3, the water features at Koele Lodge seem to be relatively free of introduced aquatic biota.

Table 2. Summary of water chemistry and other physical data for sampling sites on Lanai.

Site	Soil pH (2/site)		Water pH (2/site)		Air Temp. (°C)	Soil Temp. (°C)	Water Temp. (°C)	Salinity (ppt)
Lodge pond	—	—	8.6	8.6	19.1	19.0	21.6	0
Lodge pond			9.3	9.4	20.1	19.5	20.7	0
Putting course	—	—	9.1	9.1	20.9	19.0	21.9	0
Hole 12			8.8	8.9	18.5	19.0	20.1	0
Hole 15			9.8	9.9	18.7	20.0	20.3	0
Hole 16			9.0	9.1	18.1	19.0	20.0	0
Hole 17			9.1	9.2	17.4	19.5	20.4	0
Maunalei Gulch			8.0	8.1	22.5	21.0	24.5	0

Table 3. Distribution of Odonata at sampling sites on Lanai.

Taxon	Locality									
	LG	PC	4	8–9	12	15	16	17	18	WW
M. xantho	x	x	x	x	-	-	-	x	x	-
E. civile	x	x	x	x	x	x	x	x	x	x
I. ramburii	-	-	-	-	x	-	-	x	-	x
A. junius	x	x	-	-	x	x	x	x	x	x
O. ferru	x	-	x	x	x	-	-	x	-	-
P. flaves	x	-	x	x	x	x	x	x	-	-

Explanation of locality codes:
LG = Lodge reflecting pond; PC = putting course, 4 = 4th hole, 8–9 = 8th and 9th holes; 12 = 12th hole; 15 = 15th hole; 16 = 16th hole; 17 = 17th hole, 18 = 18th hole; WW = wastewater treatment plant.

Explanation of taxon codes:
M. xantho = *Megalagrion xanthomelas*; E. civile = *Enallagma civile*; I. ramburii = *Ischnura ramburii*; A. junius = *Anax junius*; O. ferru = *Orthemis ferruginea*; P. flaves = *Pantala flavescens*

Populations of *M. xanthomelas* were found at the Lodge Pond and its inflow streams, Holes 4, 8, 9, 17, and 18, and at the small streams on the putting course, but the species was absent at the ponds adjoining Holes 12, 15, and 16 (see Table 3). It was evident that the insects preferred the more sheltered sites, an observation congruent with that made at Ninole Springs in Kau (see following section). Numerous other Odonata were also found in these artificial systems, including the introduced damselflies *Enallagma civile* and *Ischnura ramburi*, and the dragonflies *Anax junius*, *Pantala flavescens* and *Orthemis ferruginea*. No clear correlation was evident between the presence of any of these other species at a site and the absence of *M. xanthomelas*, indicating that competitive interactions are not structuring the Odonata guilds in this system.

Detailed observations were made regarding *M. xanthomelas* behavior at several of the Koele sites. The most robust population appeared to be in the lily pond at the source of the ornamental stream feeding the Lodge Pond. Females were seen ovipositing here on floating lily pads, which exhibited numerous brown oviposition scars, and immatures were taken from the submerged roots of ferns that grew on the rock wall bordering the pool. Adults were also observed emerging from their immature castings at this site. Emergence took 30–60 min, after which the insects flew away from the water to perch in sheltered spots amid vegetation, presumably to allow their cuticle to harden. By contrast, adults in later stages of maturity were active around and above the pond, with males aggressively defending territories ca. 2 m in diameter. These adults quickly ceased activity if the sunlight was interrupted by passing clouds, indicating that *M. xanthomelas*, at least at this elevation, is very photosensitive.

At the Hole 8–9 complex, tandem pairs of *M. xanthomelas* were observed ovipositing in collapsed lily stems that hung into the water, while at Hole 4 a female was observed ovipositing on algal mats in the lowermost of three inflow basins below an ornamental waterfall. The pond at this latter site had relatively open, grass-lined banks, and in this area adults were observed only in areas where small irregularities in the shore line, such as coves formed by large rocks, provided some form of shelter.

Maunalei Gulch

The population of *M. xanthomelas* currently extant at the Koele Lodge occupies artificial habitats that did not exist prior to the early 1990s. The source of the *M. xanthomelas* population that colonized this site must thus lie elsewhere. It is possible that the insects colonized the former Koele Ranch cattle pond from populations inhabiting small springs emerging at the base of Lunaihale mountain, but no such outflows are mentioned by Stearns (1940). Instead, the most logical source from which the colonists could have come is Maunalei Gulch, a deep canyon on the northern side of Lanai that previously contained the only perennial stream on the island. A survey of the upper reaches of this gulch by the author in 1993 revealed that three species of *Megalagrion* damselflies, *M. hawaiiense* (McLachlan), *M. blackburni* McLachlan and *M. calliphya* (McLachlan) still persisted in in this catchment, but *M. xanthomelas* was not seen. In 1994, however, a specimen of *M. xanthomelas* was taken in dry forest near the mouth of Maunalei Gulch by Dr. Richard Baumann, a visiting entomologist from Brigham Young University. This discovery indicated that a colony of *M. xanthomelas* did indeed persist somewhere in the lower Maunalei system, and an attempt was thus made to locate it during the current investigations on Lanai.

An initial reconnaissance of the coast revealed no wetlands that might support the species. A foray was then made up the lower reaches of Maunalei Gulch, which is at this point a dry bed shaded by kiawe forest. A leak was eventually discovered in a small water pipeline at ca. 120 m above sea level, which created a limited outflow on a bench above and to the south of the gulch bed. *M. xanthomelas* was relatively abundant along this seepage, with many mating pairs present. The water at this site was found to have the following characteristics: temperature, 24.5 °C; salinity, 0.0 ppt; pH, 8.0. This habitat is extremely limited, and could easily be eliminated by repair or replacement of the currently leaking pipeline.

Lopa Fishpond

A good series of *M. xanthomelas* was taken from this remote fishpond near the eastern tip of Lanai by Steve Montgomery of the Bishop Museum in August 1994. Montgomery (pers. comm.) reports that the fishpond was filled with mangroves, and that the damselflies were taken along its inland margin in an area where deer were coming down to water. These observations, coupled with the presence of *M. xanthomelas*, indicate that a permanent mixohaline aquatic habitat exists at this site, probably due to weak basal spring percolation into the fishpond basin.

Keomoku

A tandem pair of *M. xanthomelas* was taken by Montgomery at this site on the same day as the specimens from Lopa were captured. The distance between these localities is over three miles, indicating the presence of two separate populations. The only water source at Keomoku is a covered well (Montgomery, pers. comm.), which seems an unlikely breeding habitat for *M. xanthomelas*, although its plumbing system may be providing artificial habitat in a manner similar to the leaking pipeline in Maunalei Gulch. It seems more likely, however, that the species is breeding in small pockets of fresh or brackish water present somewhere in the general area surrounding Keomoku. The water table along the section of the coast between Lopa and the mouth of Maunalei Gulch lies only a few meters above sea level, and in certain areas fresh water can be seen running into the sea at low tide (Stearns, 1940). Some of this water may be collecting in small natural depressions, or in the remnants of trench wells dug by settlers, and thus providing habitat for *M. xanthomelas*.

The distributions of the Lanai populations discussed above are summarized in Fig. 3.

Maui

The only specimens of *M. xanthomelas* known from Maui are four individuals in the BPBM by R.C.L. Perkins from the "West Maui Mountains" in 1894 and 1895. Perkins gave no further locality data, and one can only speculate as to the precise areas he sampled. Since Perkins' collections on West Maui during May 1894 were made entirely in the vicinity of Iao Valley, it seems likely that his specimens of *M. xanthomelas* taken in this year came from the wetlands and sand hills of the Wailuku Plain at the valley mouth, which prior to urban development in this century supported some of the most extensive sets of taro fields in Hawaii.

Another area that appears to have been capable of supporting *M. xanthomelas* was the Loko o Mokuhinia marsh at Lahaina, a basal spring wetland that was filled in for development in 1913. Pictures of Loko o Mokuhinia taken in the mid-1890's (the period when Perkins' collections were made) show a pond with floating vegetation and emergent bulrushes, similar to coastal habitats on Hawaii island in which *M. xanthomelas* breeds at the present time (Kliegeret al., 1995).

Recent surveys on Maui have found no evidence of *M. xanthomelas* populations, even at potentially suitable sites such as the coastal Kealia and Kenaha ponds. A complete circuit of the West Maui coastal lowlands was conducted in mid-1995, but failed to uncover any remaining populations, although potential habitat was available at the mouths of Makamakaole, Kahakuloa and Honokohau streams. Surveys of coastal wetlands on leeward Haleakala and at various stream mouths along the Hana Coast have been similarly

unsuccessful. Based on these results, it seems possible that *M. xanthomelas* may have been locally extirpated on Maui.

Hawaii (Big Island)

Ninole Springs

Scattered populations of *M. xanthomelas* are known from coastal wetlands in Puna, Kau and North Kona on Big Island, where limnetic groundwater percolates seaward and mixes with the inland percolating marine water table to form horizontally stratified mixohaline systems. The largest of these coastal *M. xanthomelas* populations is found in a set of limnocrenes, rheocrenes, and mixohaline marshes located at Ninole, Kau, where downslope subsurface percolation from the Ninole Hill drainages emerges just above sea level at the mouth of Ninole Stream. This is the second largest basal spring complex on the island of Hawaii (the largest being Waiakea Pond at Hilo), discharging over 20 million gallons per day in 1946 (Stearns & Macdonald, 1946), although this flow may have been subsequently modified by withdrawls from wells to irrigate sugar cane fields upslope. The water originates from lava tubes in the Kau volcanic series, and represents the subterranean outflow from ancient valleys in the nearby Ninole Hills that were filled by subsequent eruptions from Mauna Loa. Due to its origination in catchments upslope the water is quite cold, with an emergent temperature of 19 °C. This groundwater surfaces along the inland sides of coastal lava basins that have some degree of connection to the sea, creating horizontally stratified mixohaline systems with a zone of freshwater marsh along their inner margins. Similar basal spring wetlands are found at several other points along the Kau coast, including Punaluu, the mouth of Hilea Stream at Hawa Bay, Hawa Springs, and Whittington Beach Park.

The Ninole Spring wetland complex contains an extensive set of limnetic to mixohaline marshes, ponds and creeks lying at the stream mouth and in the area directly to the east, between the Sea Mountain golf course parking lot and the lava coastline. Numerous cold freshwater springs emerge just inland of the coast at the base of an a'a flow, some flowing directly into tidepools, others feeding large ponds and sloughs. One large pond with thick beds of watercress along its margins occupies a lava basin immediately east of the stream mouth, and is separated from the sea by a wall of lava ca. 3 m high, which large waves occasionally overtop. A second, even larger pond lies further to the east, in a basin just above sea level, and enters the ocean via a swift freshwater creek ca. 1 m wide and 15 cm deep. The inland margins of both these ponds grade into marshes dominated by bulrushes (*Schoenoplectus* sp.) and *honohono*; similar marshes are also present in the area between the ponds, in association with smaller spring outflows. The eastern pond also contains water hyacinth (*Eichornia crassipes*) along its inland margin.

Surveys undertaken during early May 1994 found *Megalagrion xanthomelas* to be abundant at Ninole Springs, breeding in all suitable habitats. Numerous mating pairs were observed, and many newly emerged adults were seen along the margins of the westernmost pond. A mating pair was also captured above the standing pool formed behind the cobble bar at the mouth of the stream itself. In addition, the introduced damselflies *Enallagma civile* and *Ischnura ramburi* were present along the margins of the eastern pond, especially in seaward areas exposed to the wind, but *M. xanthomelas* was clearly the dominant damselfly species across the entire Ninole system. In general the introduced damselflies seemed more abundant in open areas, while *M. xanthomelas* flew amid the shelter of vegetation along the slough channels, which were difficult to investigate, being heavily vegetated and often over 1 m in depth. The large dragonflies *Anax junius* and *Pantala flavescens* were also seen throughout the Ninole area.

The salinity of the aquatic features at Ninole Springs varied from limnetic (less than 0.7 ppt) at the outflows to fully euhaline (at least 30 ppt) at the shore, with all degrees of intermediate salinity encountered throughout the ponds and marshes. It is clear from other investigations on Molokai (see previous section) that *M. xanthomelas* can tolerate salinities of at least 2 ppt, thus it is able to breed along much of the inland margin of the Ninole wetland system.

The estuarine marshes and limnocrenes at Ninole Springs and other coastal wetlands in Kau provide extensive breeding habitats for *M. xanthomelas* that are not currently duplicated on the other high islands, although similar systems may once have existed at Pearl Harbor on Oahu prior to its urban development. Throughout such coastal situations, both here and in North Kona, *M. xanthomelas* is typically found in company with the alien *Ischnura ramburi* and *Enallagma civile*, but the competitive interactions among these species, if any, do not seem to preclude the continued presence of *M. xanthomelas* at these sites.

Hilea

A coastal wetland similar in form and origin to that seen at Ninole but of smaller extent occurs at the mouth of Hilea Stream, approximately one mile to the southwest on the opposite (western) side of an intervening lava flow. The habitat consists of several elements, beginning with a long, deep mixohaline pool at the mouth of the stream channel, which runs parallel to the base of the lava flow. This pool is separated from the sea by a cobble bar that is occasionally overtopped by high swells, and experiences a weak tidal flux. No damselflies were seen along this pool. West of the stream mouth are several small limnetic ponds bordered with sedges, grasses, and *kunolkano*; these ponds supported *Megalagrion xanthomelas*, *Enallagma civile*, *Ischnura ramburi*, *Anax junius*, *Pantala flavescens*, and *Tramea lacerata*. Even further to the west is a large basin, connecting directly to the sea via a narrow mouth, but with a zone of bulrushes at the back, bordered even further inland by an extensive, apparently limnetic marsh thickly overgrown with tall grasses. No damselflies were seen at this latter basin, but it seems likely that *M. xanthomelas* may occur in the marsh.

When this site was visited on 4 June 1994, water was being pumped from the western marsh by squatters, who were using it to irrigate small taro fields. One of these squatters claimed that the mouth of Hilea Gulch previously consisted of a large, swampy estuary, but that a major flood 4 or 5 years earlier had washed in a large amount of sediment, producing the current configuration.

Hawa Springs

This habitat consists of a small limnetic spring outflow emerging at the base of an eroded lava flow, and flowing into a linked series of progressively more saline ponds scattered along a sinuate depression behind the shoreline. The overall impression is one of an interrupted tidal creek, bordered by grasses and sedges. During a survey on 4 June 1994 the limnetic pools near the head of this system supported populations of *Megalagrion xanthomelas* and *Anax junius*; no introduced damselflies were seen. The area appears to be in a relatively natural condition, and does not appear to be frequently visited.

Whittington Beach Park

A single large pond behind the shoreline at Whittington Beach Park receives limnetic inflow along its inland margin, while connecting to the sea via a narrow mouth along the ocean side. A mixohaline gradient appears to exist across the width of this pond, with the seaward portion being essentially euhaline, but changing to mixohaline as one progresses inland. The basin here is similar in extent to the large eastern pond at Ninole, but is not raised above sea level as in the former case. The back margin of the Whittington pond is bordered with low grasses and bulrushes, indicating that a narrow freshwater zone exists as a result of limnetic downslope percolation into the basin. *Megalagrion xanthomelas* was found here on 4 June 1994, with adults flying low amid the shelter of the vegetation along the back edge of the pond. No individuals were seen along the front edge of the pond nearer to the sea. Cattle have disturbed this system, but do not appear to pose a threat to the long term stability of the marsh.

Kaloko Fishpond

A large fishpond and many other smaller anchialine pools are found in this area. David Foote of the National Biological Service, Hawaii Volcanoes National Park, has taken numerous specimens of *M. xanthomelas* from this site and documented their occurrence in the various habitats present.

Kiholo Bay

A complex of wetlands containing numerous anchialine ponds and pools occurs along the margins of Kiholo Bay. Access is difficult due to private ownership, and the area remains poorly surveyed. During the present study it was possible to walk down the shore along the northern end of the bay and sample a large, apparently mixohaline pond that lay immediately behind the beach ridge. One specimen of *Megalagrion xanthomelas* was taken here, in company with *Ischnura ramburii*, which was abundant.

Anaehoomalu Bay

One of the most extensive sets of anchialine pools known on the North Kona coast formerly occurred along the northern margin of Anaehoomalu Bay, at a site now occupied by the Waikoloa resort. These pools were bulldozed in the course of resort development, but similar systems, though smaller in extent, still exist along the southern margin of the bay, in a complex owned by Parker Ranch and known as the "Parker Ponds". In this area the shore forms a high dune ridge, behind which lie a series of depressions, marked by palms, containing mixohaline marshes and bordered by low, halophytic vegetation, predominantly pickleweed (*Batis maritima*). A specimen of *M. xanthomelas* was taken along the margin of one of these basins on 7 June 1994, in company with the introduced *Ischnura ramburi*, which was abundant. Although the salinity of these marshes was not ascertained, females of *Anax junius* were seen ovipositing in them, indicating that in at least some sections it must be quite low.

Beyond the marshy basins to the southwest lies a set of rock rimmed anchialine pools, some forming large ponds with bulrushes along their margins. No damselflies were seen in this area, but two dragonfly species, *Anax junius* and *Tramea lacerata*, were observed. The overall Parker Pond system is relatively undisturbed, and further surveys in the area would be useful in order to localize the sources of limnetic inflow, around which

M. xanthomelas would be likely to congregate. The area has recently been sold by the Parker Ranch, but alteration of the pools and marshes should be discouraged if possible, since they represent the last remaining undisturbed portion of the formerly extensive Anaehoomalu anchialine pool complex, which was described in detail by Maciolek & Brock (1974).

The large Kuualii and Kahapapa fishponds at the Waikoloa resort were also surveyed, along with a complex of smaller adjacent anchialine pools containing red shrimps. All these habitats proved either too saline or too ecologically altered to support damselfly populations, and a search for further, more limnetic habitats in the general area was unsuccessful. A few *Anax junius* and *Pantala flavescens* were observed, but these may have been strays from populations breeding in nearby golf course ponds. An extensive set of anchialine pools formerly occurred to the north of this site, near Waiulua Bay (Maciolek and Brock, 1974), but these were destroyed in the course of resort development and no longer exist.

Leleiwi Point

A population of *M. xanthomelas* was found breeding in an anchialine pool system at Leleiwi Point by David Foote when he surveyed the area on 20 March 1995. Foote reports that the site consists of a large anchialine pond with a lava rubble and coral sand bottom. The submerged rocks are covered by a layer of light brown algal growth, and the pond margins are set with a dense growth of California grass (*Urochloa mutica*) that form floating mats in several places. A small patch of *Wedelia trilobata* also occurs along the shore in an area shaded by kou (*Hibiscus tiliaceus*). Water conductivity ranged from 4.86–6.52 mS, and the water temperature averaged 19 °C, indicating the pond is fed by a basal spring. Males of *M. xanthomelas* were observed along the pond margins, along with 1 tandem pair. Other Odonata at this site included the introduced damselflies *Enallagma civile* and *Ischnura ramburii*, and the dragonfly *Anax junius*.

The pond at Leleiwi is part of a very large system of anchialine pools and estuarine limnocrenes that extends from this point westward along the coast to Hilo, and includes Waiakea Pond, the largest basal spring in Hawaii. Individuals of *M. xanthomelas* were observed at Liliuokalani Park within Hilo itself in October 1995, and historical collections are present from Coconut Island immediately offshore, suggesting a long-standing population of *M. xanthomelas* in this area.

Onomea Stream

This is a relatively short catchment heading at approximately 275 m elevation and flowing for 3 km to a seaward terminus in Onomea Bay, north of Hilo. The stream exhibits a steep profile typical of drainages on the Hamakua Coast, descending stair-step fashion via waterfalls in a bed of hard basalt. The seaward terminus, lying within the Hawaii Botanical Garden, consists of a long, flowing freshwater pool impounded behind a cinder beach, with a waterfall at its head. Progressing upstream one encounters a series of falls and plunge pools heavily shaded by introduced figs, palms and bamboo, until the bridge on the Pepeekeo Scenic Drive is reached. Immediately above this road crossing the stream is less confined, and forms long, partially shaded flowing pools, which continue to the base of another high waterfall.

The terminal reach and lower midreach of this system both up and downstream of

the Pepeekeo Scenic Drive were surveyed on 8 June 1995. *Megalagrion xanthomelas* and *M. hawaiiense* were found along the pooled midreach section of the stream at 55 m elevation, just upstream from the road, but no damselflies were seen along the terminal reach in the botanical garden. Individuals of *M. xanthomelas* were observed perching on low ferns, dead palm fronds, and bare rocks along the channel margins. Immatures were not found, but are likely to inhabit the trailing submerged root mats that are well developed here.

Alakahi Stream

This is a short, steep catchment approximately 2 km long, heading at about 230 m elevation and terminating in Onomea Bay adjacent to Onomea Stream. The stream presents a steep profile, descending through a bed of mossy boulders, heavily shaded by a forest of introduced trees. The terminal reach and lower midreach of this system upstream of the Pepeekeo Scenic Drive were surveyed on 8 June 1995. *Megalagrion xanthomelas* and *M. blackburni* were found between 55 and 75 m elevation, up to a point where hau (*Hibiscus tiliaceus*) begins to heavily overtop the stream; the former species was found even in areas of dense shade, an unusual habitat preference (see comments under sections on Lanai and Molokai). No damselflies were seen along the lower section of the stream below the road, in the area where it passes through the Hawaii Botanic Garden, despite the presence of suitable habitat, including a large ornamental pond adjacent to the stream itself.

Kawainui Stream

This is a large volume catchment that flows through a steeply dropping basalt bed and reaches the sea in an incised fjord south of Pepeekeo. At 60 m elevation the stream flows through a natural archway formed by an old lava tube. The lower midreach of this system immediately downstream of the Pepeekeo Scenic Drive was surveyed on 8 June 1995. *Megalagrion xanthomelas* adults and immatures were taken at small side pools in bedrock adjacent to the main channel, and bordered by clumps of yellow flowering *Wedelia trilobata*. Other adults were taken next to seepage fed pools on bedrock shelves along the south bank of the stream immediately across from these side pools. Heavy rains several days later caused the stream to rise appreciably, completely covering the side pool habitats with swiftly flowing water (although the seeps were not affected). It thus appears that at this site *M. xanthomelas* is exploiting temporary habitats on an opportunistic basis.

This and other *M. xanthomelas* populations found along drainages entering Onomea Bay probably represent a northward extension of the populations centered around the estuarine limnocrenes at Hilo. To date *M. xanthomelas* has not been found to the north along the Hamakua Coast past Pepeekeo Point, despite surveys at suitable stream mouths between there and Honokaa. Most of the streams in the Hamakua area end in terminal falls, and of those few that do not the following have been surveyed: Kolekole, Hakalau, Honolii, and Laupahoehoe. Several others, such as Maulua and Nanue, still await surveys, but it is considered unlikely that they harbor *M. xanthomelas* populations based on current findings.

Kapoho

An extensive series of anchialine and mixohaline wetlands fed by basal springs is found along the shoreline to the east of Kapoho Crater, in Puna, developed amid a series of recent lava flows that have been subject to coastal subsidence. Searches were made along the seaward edge of this system between 8 and 9 June 1995, both north and south of Kapoho Point. *Megalagrion xanthomelas* was found in the former area, which is being developed into residential subdivisions, with adults patrolling along the margins of moderately saline (8.0–8.5 ppt) pools. Current USGS maps do not correctly reflect the coastline profile and adjacent wetlands in this area, since extensive subsidence took place after their last update in 1981.

The interior of nearby Kapoho Crater contains a water filled basin known as Green Lake, which has no outlet and appears to be fed by seepage from the surrounding crater walls. This lake, which is essentially circular and ca. 100 m across, has silty, greenish waters with a temperature of 27 °C, and supports an overwhelmingly alien aquatic biota including frogs, topminnows, and numerous introduced aquatic plants. The shores are thickly lined with bamboo, kukui, breadfruit, mango and other exotic vegetation. Two males of *M. xanthomelas* from this locality, taken by F.X. Williams in 1936, are present in the collection of the Hawaii State Department of Agriculture. A survey of the lake and its surroundings in good weather failed to detect any sign of this species, although the introduced damselflies *Ischnura ramburii* and *Enallagma civile* were abundant, in company with the dragonflies *Anax junius* and *Pantala flavescens*. It is assumed that the introduction of alien fishes and frogs at Green Lake has led to the extirpation of this population of *M. xanthomelas*.

The distributions of the Hawaii populations discussed above are summarized in Figure 4.

Summary

The present surveys of *M. xanthomelas* demonstrate that the species occupies a wide range of habitats and has broad ecological tolerances. The most common habitats in which this species occurs are coastal wetlands fed by basal springs, as seen in the Puna, Kau and North Kona districts of Hawaii, at Palaau on Molokai, and formerly at Pearl Harbor on Oahu. This species also occasionally breeds along the terminal and lower midreaches of perennial streams, as illustrated by the populations at Pelekunu and Waikolu streams on Molokai, and at Onomea Bay on Hawaii island. Given the absence of introduced aquatic biota, *M. xanthomelas* can also breed in reservoirs and ornamental ponds, as recorded previously by Williams (1936), and currently documented at the Koele Lodge on Lanai. The species will also opportunistically exploit temporary habitats, as shown by its occupation of ephemeral side pools bordering flashy streams on Hawaii Island, and pipeline seepages on Lanai.

Although *M. xanthomelas* has a recorded elevational range of 0–1000 m above sea level (Perkins, 1899), it is generally a lowland species, with most of the known populations now occurring below 60 m, and the highest recent records coming from 610 m, in artificial settings on Lanai. Results from salinity readings taken at Palaau, Molokai demonstrate that the species can tolerate salt concentrations of at least 2 ppt, and circumstantial evidence from habitats in Puna and North Kona indicates that the tolerance may be as high as 8 ppt. Based on results from Lanai the species also does not seem to be

adversely affected by commercial anti-algal treatments such as AquaShade and copper sulphate, which are commonly used in hotel and golf course water features. The species was found breeding in habitats with water temperatures ranging from 20–31 °C, and with pHs ranging from 6.6–9.2.

In terms of interactions with alien aquatic species, *M. xanthomelas* seems to be able to tolerate the presence of carp and apple snails, but does not do well in habitats containing guppies or top minnows. There is no indication of adverse competitive interactions between *M. xanthomelas* and the widespread introduced damselflies *Ischnura ramburii*, *Isclnura posita*, and *Enallagma civile*, with which it frequently co-occurs.

Despite its broad range of ecological tolerances, *M. xanthomelas* is becoming increasingly rare in Hawaii, having apparently been extirpated from two islands, Kauai and Maui, on which it previously occurred, while being perilously close to extirpation on Oahu. Based on our current understanding of the species' biology, this loss of *M. xanthomelas* populations is linked more to the introduction of alien aquatic biota than to outright habitat alteration or destruction. On one hand this is a source of optimism, since this pattern of decline can perhaps be stabilized through protection of remaining natural habitats or construction of suitable refugia. On the other hand, it is also a source of pessimism, since the continuing onslaught of alien aquatic species in Hawaii shows no signs of abatement (Eldredge 1994).

Acknowledgments

The surveys on which this report was based could not have been accomplished without the assistance of the following individuals, who provided permits, logistical support, and local knowledge that were essential in locating the remaining populations of *M. xanthomelas*: David Foote, National Biological Service, Volcano; Adam Asquith, USFWS, Honolulu; Robert Kinzie, University of Hawaii, Manoa; Bill Puleloa, Hawaii Division of Aquatic Resources, Molokai; Ed Misaki and Joan Yoshioka, The Nature Conservancy of Hawaii, Molokai; Robert F. Donovan, Michael J. Dixon, Kurt Matsumoto of the Lodge at Koele and The Experience at Koele golf course, Lanai City, Lanai; Ron Englund, Pacific Aquatic Environmental, Honolulu; Bill Devick, Hawaii Division of Aquatic Resources, Honolulu; and Eric Pacheco, Pacific Helicopter Tours, Inc., Kahului, Maui.

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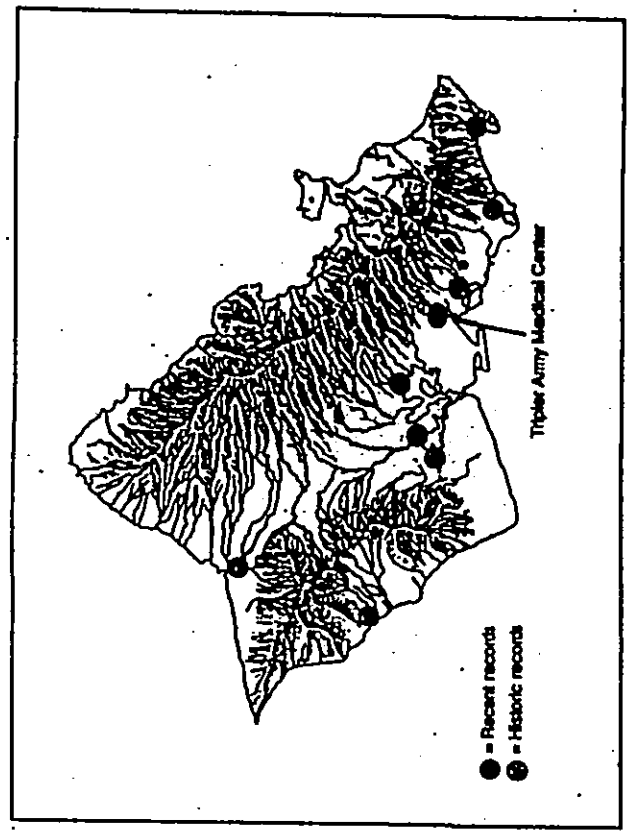

Fig. 1. Map of Oahu, showing locations of current and historic records for *Megalagrion xanthomelas*.

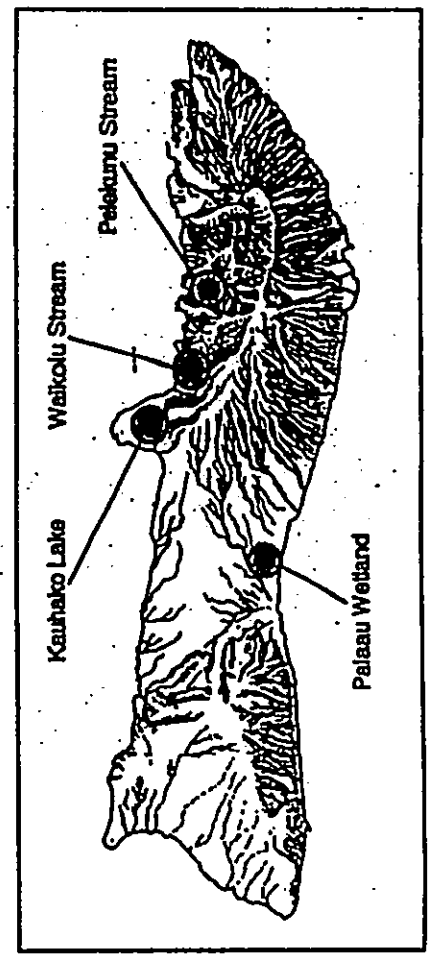

Fig. 2. Map of Molokai, showing currently known populations of *Megalagrion xanthomelas*.

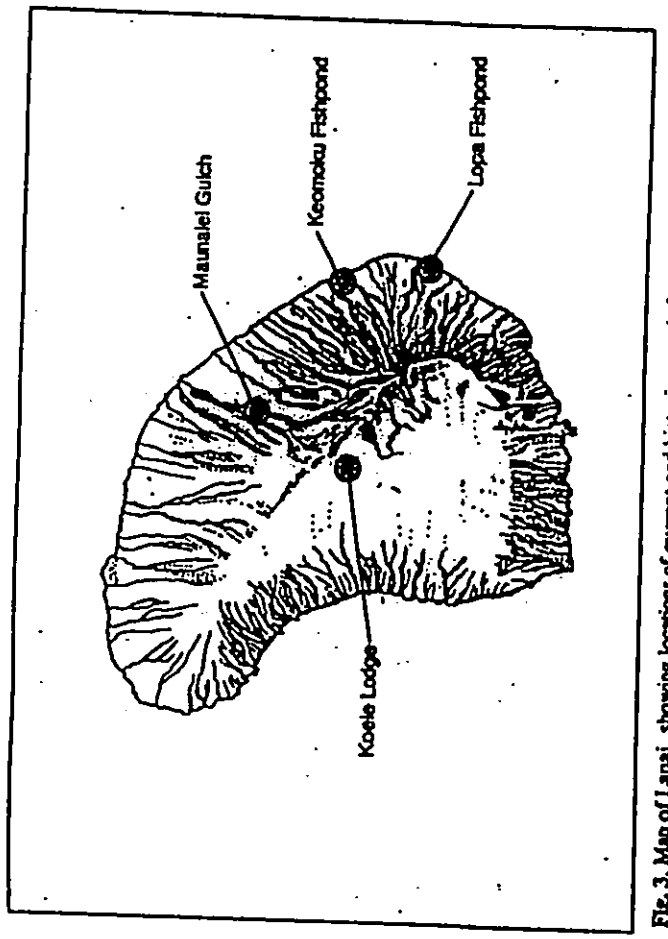

Fig. 3. Map of Lanai, showing locations of current and historic records for *Megalagrion xanthomelas*.

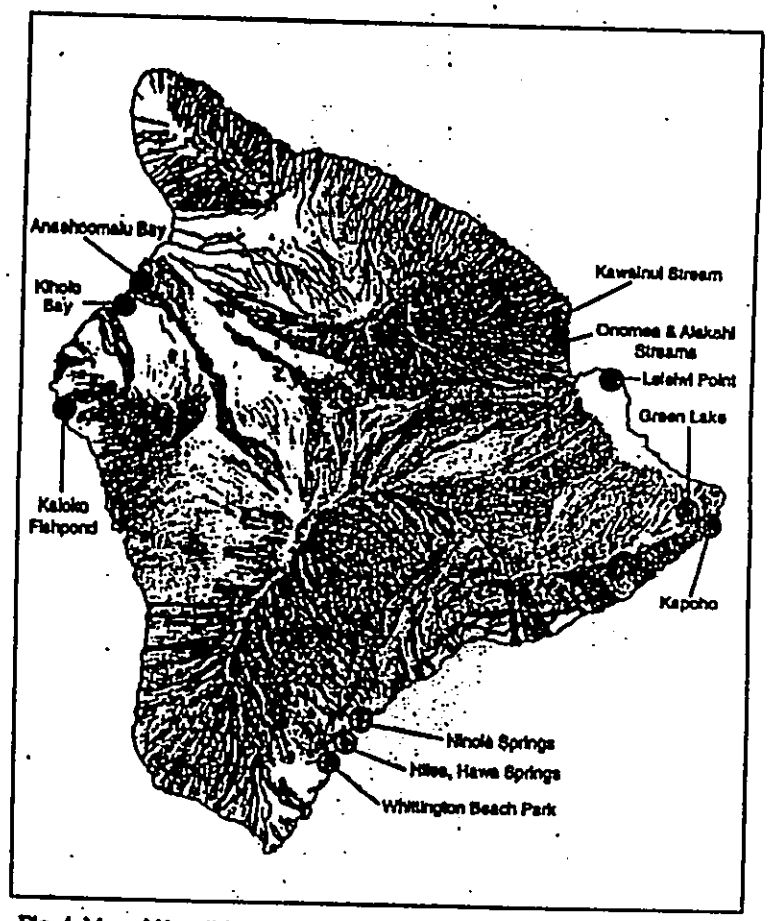

Fig. 4. Map of Hawaii Island (Big Island), showing known populations of *Megalagrion xanthomelas*.

Report 2381-012804

Historic Properties Assessment Survey
New Aviary Project
Hawai'i Tropical Botanical Garden

Land of Onomea, South Hilo District

Island of Hawai'i

Exhibit 10

PHRI

Paul H. Rosendahl, Ph.D., Inc.

Archaeological • Historical • Cultural Resource Management Studies & Services

Report 2381-012804

Historic Properties Assessment Survey
New Aviary Project
Hawai'i Tropical Botanical Garden

Land of Onomea, South Hilo District
Island of Hawai'i (TMK:3-2-7-09:2)

BY

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SUMMARY

At the request of Mr. Scott A. Lucas, Administrator, Hawai'i Tropical Botanical Garden (HTBG), Paul H. Rosendahl, Ph.D. (PHRI), conducted an archaeological assessment survey of the New Aviary project area, situated within the grounds of the Hawai'i Tropical Botanical Garden, Land of Onomea, South Hilo District, Island of Hawai'i (TMK:3-2-7-09:2)(*Figure 1*). The survey was conducted in connection with the preparation and processing of an Environmental Assessment (EA) and a related Conservation District Use Permit application. The overall objective of the survey was to obtain from the Hawai'i State Historic Preservation Division (SHPD) a formal determination of "no historic properties affected" for the New Aviary project area, in accordance with the Hawai'i Administrative Rules, Title 13, Subtitle 13, Chapter 284: Section 5(b).

The field survey of the project area was conducted on January 14, 2004. One hundred percent of the surface of the New Aviary project area was inspected. The subsurface survey was conducted by the placement of 13 shovel test probes (STPs) placed around the perimeter of three existing birdcages.

No significant archaeological or other cultural remains were found within the New Aviary project area. The only cultural materials identified were several ceramic fragments, and these were in a probable secondary context.

During preparation of the Environmental Assessment for the current project area, Ms. Debra Ward of Moku Loa Group – Sierra Club raised the question of the possible existence of an ancient grave site beneath the current project site, claiming that sometime back in the 1980s someone informed her that this was the case. During the current surface and subsurface survey nothing remotely resembling a possible grave site was encountered. Based on the findings of the survey, it is our opinion that it is highly unlikely the project area contains graves. Perhaps the information given Ms. Ward was in reference to historic graves on the coastline (see page 3, paragraph 5; and *Figure 1*).

The detrimental effects of construction within the New Aviary project area has been mitigated by the pedestrian survey and STP excavation program. No further archaeological work is recommended in the project area, and it is recommended that an SHPD determination of "no historic properties affected" be granted (in accordance with the general guidance provided by Chapter 284: Section 5[b] of the SHPD Rules, HAR Title 13, DLNR; Subtitle 13).

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INTRODUCTION

BACKGROUND

At the request of Mr. Scott A. Lucas, Administrator, Hawai'i Tropical Botanical Garden (HTBG), Paul H. Rosendahl, Ph.D. (PHRI), conducted an archaeological assessment survey of the New Aviary project area, situated within the grounds of the Hawai'i Tropical Botanical Garden, Land of Onomea, South Hilo District, Island of Hawai'i (TMK:3-2-7-09:2)(*Figure 1*). The survey was conducted in connection with the preparation and processing of an Environmental Assessment (EA) and a related Conservation District Use Permit application. The overall objective of the survey was to obtain from the Hawai'i State Historic Preservation Division (SHPD) a formal determination of "no historic properties affected" for the New Aviary project area, in accordance with the Hawai'i Administrative Rules, Title 13, Subtitle 13, Chapter 284: Section 5(b).

SURVEY OBJECTIVES AND SCOPE OF WORK

The basic objectives of the assessment survey were to determine the following: (a) the general nature, extent, and potential significance of any historic properties (archaeological-historical remains) that might be present, (b) the historic preservation implications of any such properties for the feasibility of any proposed future development; and (c) the general scope of work and level of effort for any subsequent archaeological–historic preservation work that might be appropriate and/or required. The ultimate objective of any such subsequent work would be to comply with all current historic preservation requirements of the Hawai'i State Historic Preservation Division (SHPD) and the Hawai'i County Planning Department (HCPD).

Based on discussions with Mr. Scott A. Lucas, a review of prior archaeological work done in 1995 by Scientific Consultant Services (SCS) (McGerty and Spear 1995a) within the HTBG grounds, prior archaeological work done by PHRI within the general vicinity of the subject property, and our familiarity with both the general project area and the current regulatory review requirements of the SHPD and the HCPD, the following scope of work was determined to be appropriate for the assessment survey:

1. Conduct appropriate background review and research;
2. Mobilization – including all fieldwork preparations, field crew travel time, and demobilization;
3. Conduct high-intensity, 100% pedestrian coverage, surface reconnaissance fieldwork of the subject property area and immediate vicinity;
4. Conduct limited subsurface testing of the subject project area only;
5. Conduct post-field analysis of field and other data;
6. Prepare a written assessment survey report – including description and evaluation of assessment survey findings, and a scope of work and cost estimate for any additional archaeological work that might be required by various regulatory agencies in connection with any development applications; and
7. Coordinate and consult with client, client representatives, agency staff, etc. (as appropriate and/or required).

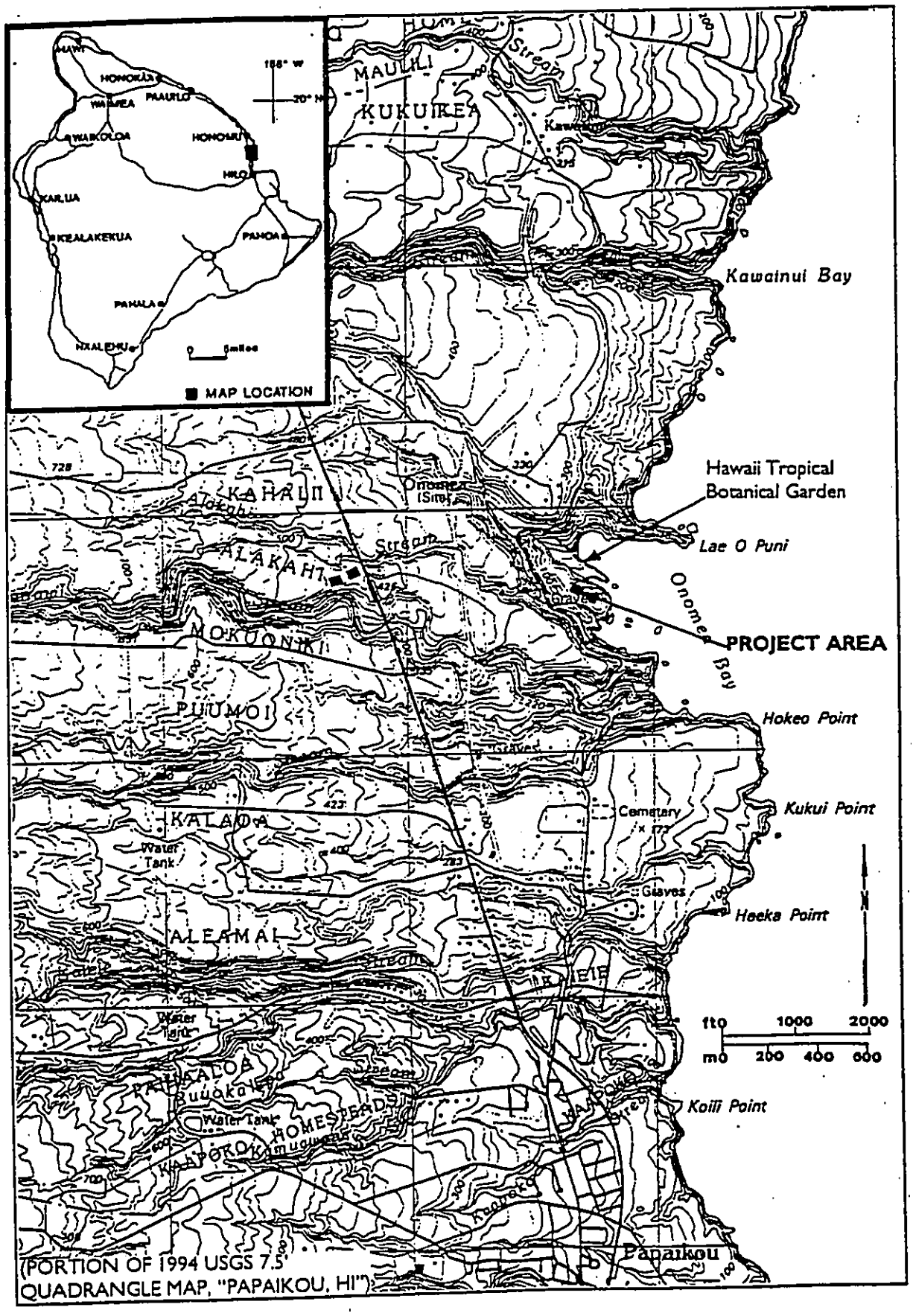

Figure 1. Project Location

PROJECT AREA DESCRIPTION

The project area is located within the Hawai'i Tropical Botanical Garden at an elevation of sea level to 220 ft AMSL (above mean sea level)(*Figures 1 and 2*). The garden, a tourist attraction consisting of a wide variety of tropical vegetation in a rainforest setting, is bounded by Mamalahoa Highway on the west and south, the Pacific ocean on the east, and undeveloped land owned by the garden to the north.

The soils in the HTBG are classified as Rough Broken Land (RB) (Sato et al. 1973: Sheet 65). This is a land type consisting of very steep, precipitous land broken by many intermittent drainage channels, with scattered waterfalls. The soils range from very shallow to deep, with stones and rock outcrops being common in some areas (Sato et al. 1973:51). Rainfall in the project area is c. 125-150 inches per year, and the mean annual temperature is approximately 75 degrees F (Armstrong 1983:63,64).

The specific New Aviary project area is about 40 by 60 feet and encompasses three existing birdcages. Each existing cage measures 2.43 m (8.0 ft) by 2.43 m (*Figure 2*). Plans are for building a single larger cage that encompasses all three existing cages. The new larger cage would be confined to the 40-60 foot project area.

PREVIOUS PERTINENT ARCHAEOLOGICAL RESEARCH

Previous archaeological work in the general vicinity of the project area includes investigations by Thrum (1908), Hudson (n.d.), and Goldstein (pers. comm. to Alan Walker, PHRI Supervisory Archaeologist; PHRI 1991a). In 1908, Thrum identified a *heiau* in the vicinity of the present project area (Thrum 1908). This *heiau*, according to Thrum, was located above a road (probably the old Mamalahoa Highway), in a sugarcane field, and was in ruins. Although there is no available map, other information by Thrum indicates this *heiau* was located outside the present project area (PHRI 1991a). Hudson (n.d.) also mentions this *heiau* but was unable to locate the ruins. Hudson noted that a Hawaiian community, a fishing and taro-producing village, still existed at Onomea Bay, and he mentions house platforms and agricultural terraces in a gulch that may be associated with the village.

In 1982, Goldstein conducted a survey of HTBG but did not identify any archaeological resources other than several features on the coastline that appeared to be graves (PHRI 1991a). These graves are shown on a recent USGS 7.5" series quad map ("Papaikou, Hawaii"; *Figure 1*). The graves, located well away from the current New Aviary project area, are those of some of the last residents of the Hawaiian village of Kahali'i (McGerty and Spear 1995), which was located partly within the overall HTBG project area. Some of the graves are encased in or under large, above-ground cement structures.

In May 1991 PHRI surveyed 40 acres just north of the present park boundaries (PHRI 1991a) but found no archaeological resources. PHRI then conducted additional research on HTBG property to gather more information on an old government road that may have extended through the garden property at one time. Evidence gathered indicated that a road (Government Road) did exist at one time, running between the coast of Onomea and the present scenic rout. Prior to being the Government Road, it may have been a prehistoric trail (PHRI 1991b).

In 1995 SCS conducted an archaeological inventory survey within Areas A, B, and C of the HTBG (*Figure 3*)(McGerty and Spear 1995a). In Area A, a survey produced no archaeological materials. In Area B, excavation of three shovel test probes produced no cultural remains. In Area C, excavation of two backhoe trenches produced *kukui* fragments, a volcanic glass flake, and recent historic debris, including

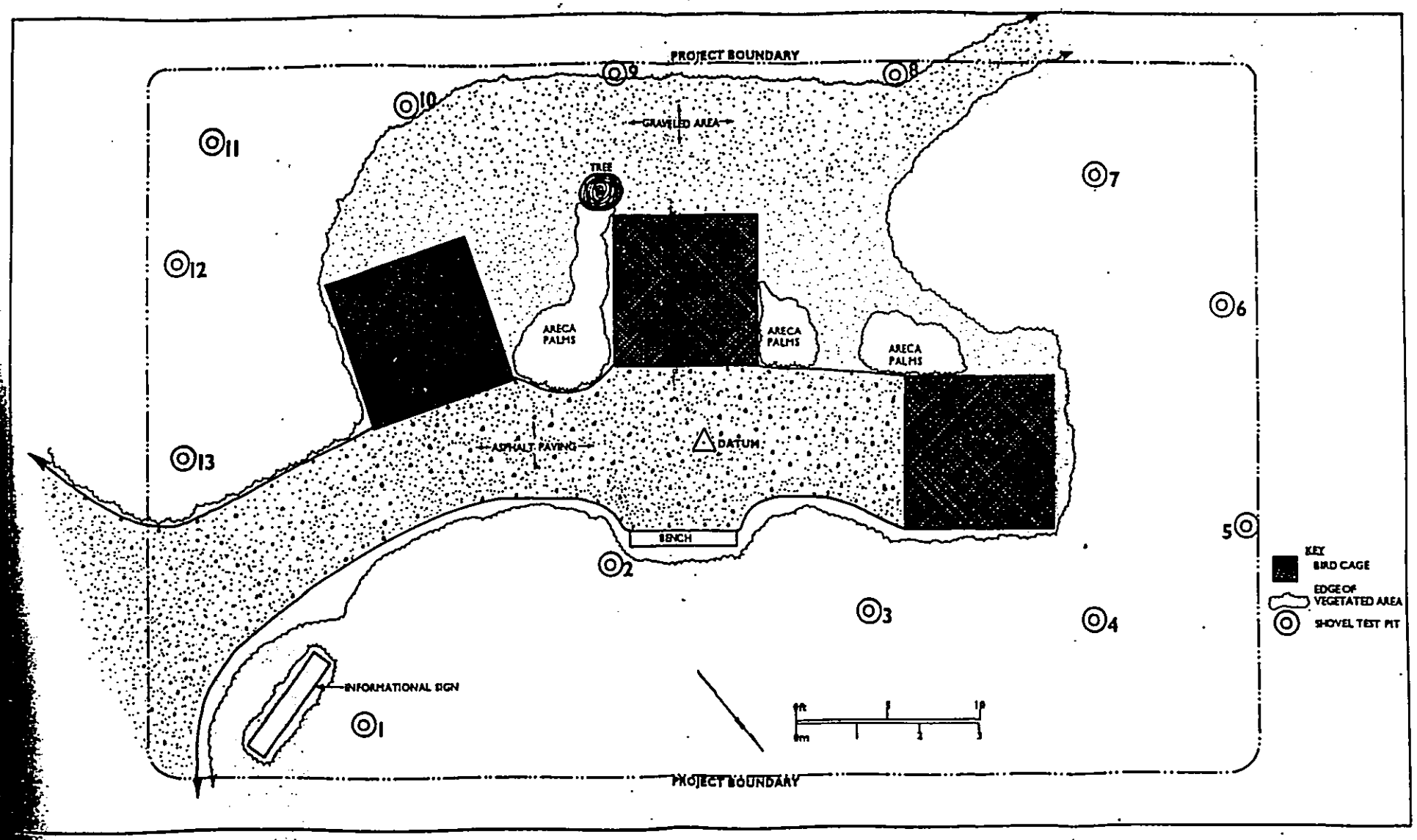

Fig. 2. New Aviary Project Area

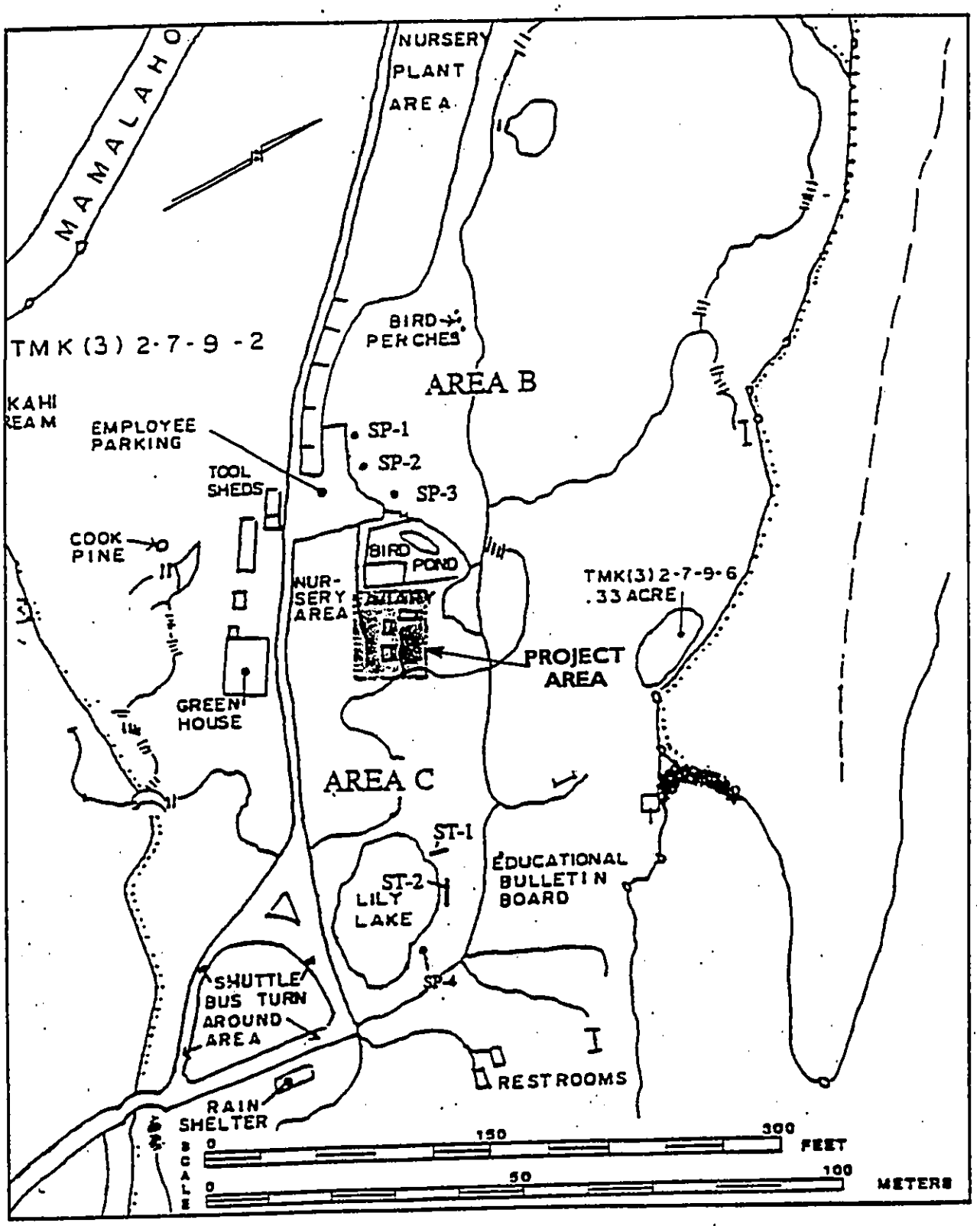

Figure 3. Plan View of Areas B and C, Showing Locations of Shovel Probes (SP) and Stratigraphy Trenches (ST) (taken from McGerty and Spear 1995a)

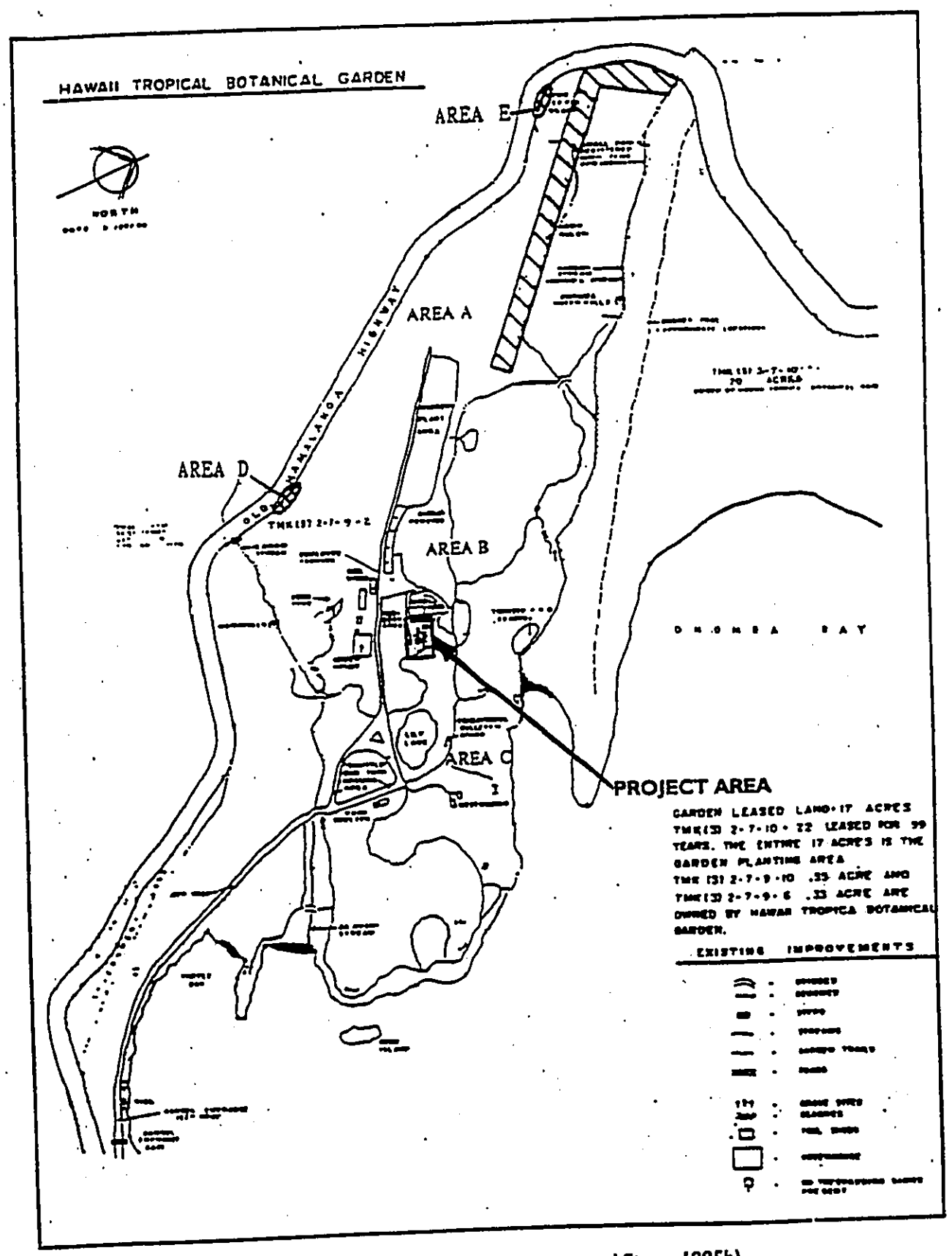

Figure 4. Plan View of Areas D and E (taken from McGerty and Spear 1995b)

glass and ceramic fragments. It was concluded that a low-density cultural deposit was present in the area of Lily Lake.

Later in 1995, SCS surveyed Areas D and E (*Figure 4*). In Area D several terraces were recorded, and historic materials were noted as having been washed downslope from or out of a soil-surfaced, faced terrace. Previous to this, a survey by Marc Smith of the SHPD had noted these terraces (McGerty and Spear 1995b). Lastly, in 1996, Marc Smith monitored trail improvements in the garden and found a recent historic dump along Onomea stream (memorandum from Marc Smith to Patrick McCoy, 1996).

PREHISTORIC SETTLEMENT PATTERN AND HISTORIC INFORMATION

Drawing on information found in previous archaeological work and historical documentary information, general settlement patterns for this area of Onomea can be surmised. Because this area of Onomea contains a permanently flowing stream and a variety of offshore reef environments offering a wide range of marine resources, it offered an attractive and ecologically optimal environment for early Hawaiians. Occupation of the Onomea Bay area probably focused on the flatter areas on the south side of the bay (outside the present project area), and marine resource exploitation and irrigated agriculture were probably major subsistence activities. As noted by Hudson (1932), irrigated agricultural terraces were located around the fresh water streams during the historic period. This is a practice that probably originated during the prehistoric period (PHRI 1991a).

Historical information states that the fishing village of Kahali'i was located on a large point of land that extends into Onomea Bay (apparently the same point of land on which the HTBG is located). This village became a shipping terminal for schooners and steamers until building of the railroad line from Hilo to Pa'auilo was completed. The Hawaii Consolidated Railway began in 1899, but was put out of business when the tsunami of 1946 destroyed the entire line. Tsunami waves reached heights of 35 feet above sea level in Onomea Bay and demolished the entire area; a few remnants of the village at Kahali'i can still be seen (PHRI 1991a).

When the Great Mahele took place in 1848, the *ahupua'a* of Onomea was awarded to Victoria Kamamalu (Land Commission Award 7713). Being an *ali'i* Kamamalu was not required, as were the common people, to submit testimony for her awarded lands; thus no information exists regarding her property. The only other Land Commission Award in the *ahupua'a* was a parcel of one acre given to Samuela. The testimony for this award states it was being disputed and does not give information on land use (Foreign Testimony, Vol. 5:26); the award does not appear to be located within the overall HTBG project area (PHRI 1991a).

A number of grants were awarded in Onomea prior to the 1888 creation of the Onomea Sugar Company, and a few were awarded prior to 1863, when Onomea Plantation began operations. Grant 2366 was awarded in 1857 to Kiolakia. Grant 3476 was awarded to Onomea Sugar Company in 1890. Grant 2945 was awarded to Lohi in 1864, and a parcel from Grant 2881 was sold to Keawiuaole in 1863. Grant 1962 was awarded to Kaumiumi in 1856 and was sold in 1895 to Onomea Sugar Company. A few awards were made to the Onomea Sugar Company. This company was formed in 1888 through a consolidation of three smaller companies, the Paukaa, Papaikou, and Onomea plantations. Onomea Plantation had been started in 1863 and had the reputation of being the most advanced and best-equipped plantation of its time.

Sometime after Hudson's work, referred to above, the valley was abandoned except for two people who remained until the time of the tidal wave in 1946, at which time the area was decimated. Later, the area around the present Lily Lake was used as a *lilikoi* farm and for cattle grazing (McGerty and Spear 1995).

FIELD METHODS AND PROCEDURES

The surface pedestrian survey of the project area was conducted on January 14, 2004 by PHRI Supervisory Archaeologist Alan B. Corbin, M.A., and PHRI Assistant Field Archaeologist/Senior Editor Leonard Kubo. The project area was surveyed by way of pedestrian transects oriented north-south, with two-meter spacing between sweeping crewmembers. Visibility was excellent and 100% of the New Aviary was inspected. The subsurface survey was conducted by the placement of 13 shovel test probes (STPs) placed around the perimeter of the three existing birdcages (*Figure 2*). The STP's were spaced approximately 4.0 meters apart and were approximately 0.50 m in diameter. Each STP was either excavated to bedrock or was terminated at 0.85 meters below surface. In all cases of pits excavated to 0.85 meters, prior to termination of the unit at least 0.50 meters of soil was excavated without encountering cultural materials. All excavated soil was screened through ¼-inch screen mesh. Soils and stratigraphic information was recorded following U.S. Soil Conservation Service guidelines and Munsell color notations. The excavated STPs were then backfilled. Artifacts recovered from the screening process were weighed, counted, and described.

FINDINGS

The stratigraphies of the thirteen STPs excavated were generally similar. Except for STP-10 all of them contained one or two soil layers. STP-10 had a Layer I of gravel fill, and Layers II and III consisted of what was, respectively, Layer I and Layer II in the other units. Layer I soil was consistently a dark brown (7.5 YR 3/3 silty clay loam; slightly hard; moderate grade, coarse size, friable, slightly sticky, slightly plastic, with a crumb form. Layer II soil was consistently a dark brown (7.5 YR 3/2) silty clay loam slightly hard, weak grade, medium size, friable, slightly sticky, slightly plastic with a crumb form. The amount of roots in the probes varied. *Table 1* summarizes the findings of the STPs, while *Figure 5* is a photograph of a representative example of the STPs.

Table 1. Summary of Shovel Test Pits

STP No.	Layer Depth (m)		Roots	Bottom of Excavation		Cultural Materials Identified	Comments
	I	II		Bed-rock	0.85 mbs		
1	0.0-0.44	0.44-0.85	few	-	x	x	Two ceramic pieces (fit together) at approx. 0.05-0.10 mbs; see text
2	0.0-0.16	-	few	x	-	-	-
3	0.0-0.37	-	few	x	-	-	-
4	0.0-0.37	0.37-0.57	many	x	-	-	-
5	0.0-0.30	-	many	x	-	-	Bedrock is slightly decomposing
6	0.0-0.10	-	few	-	-	-	Disturbed area; hit concrete fence post foundation; STP abandoned
7	0.0-0.28	0.28-0.85	few	-	x	-	Very disturbed area
8	0.0-0.25	0.25-0.50	few	x	-	-	-
9	0.0-0.20	0.20-0.83	Common in Lay I; few in Lay II	x	-	-	-
10	0.0-0.13	0.13-0.34	Common in Lay II; few in Lay III	-	x	-	Lay I is gravel; Lay II corresponds w/ Lay I in other pits; Lay III corresponds to Lay II in other pits
11	0.0-0.22	-	many	-	-	-	STP abandoned due to impenetrable roots
12	0.0-0.17	0.17-0.85	many	-	x	x	4 ceramic pieces (fit together) at c. 0.22 mbs; see text
13	0.0-0.30	0.30-0.85	many	-	x	-	-

STP=Shovel Test Pit (m)=meters mbs=meters below surface

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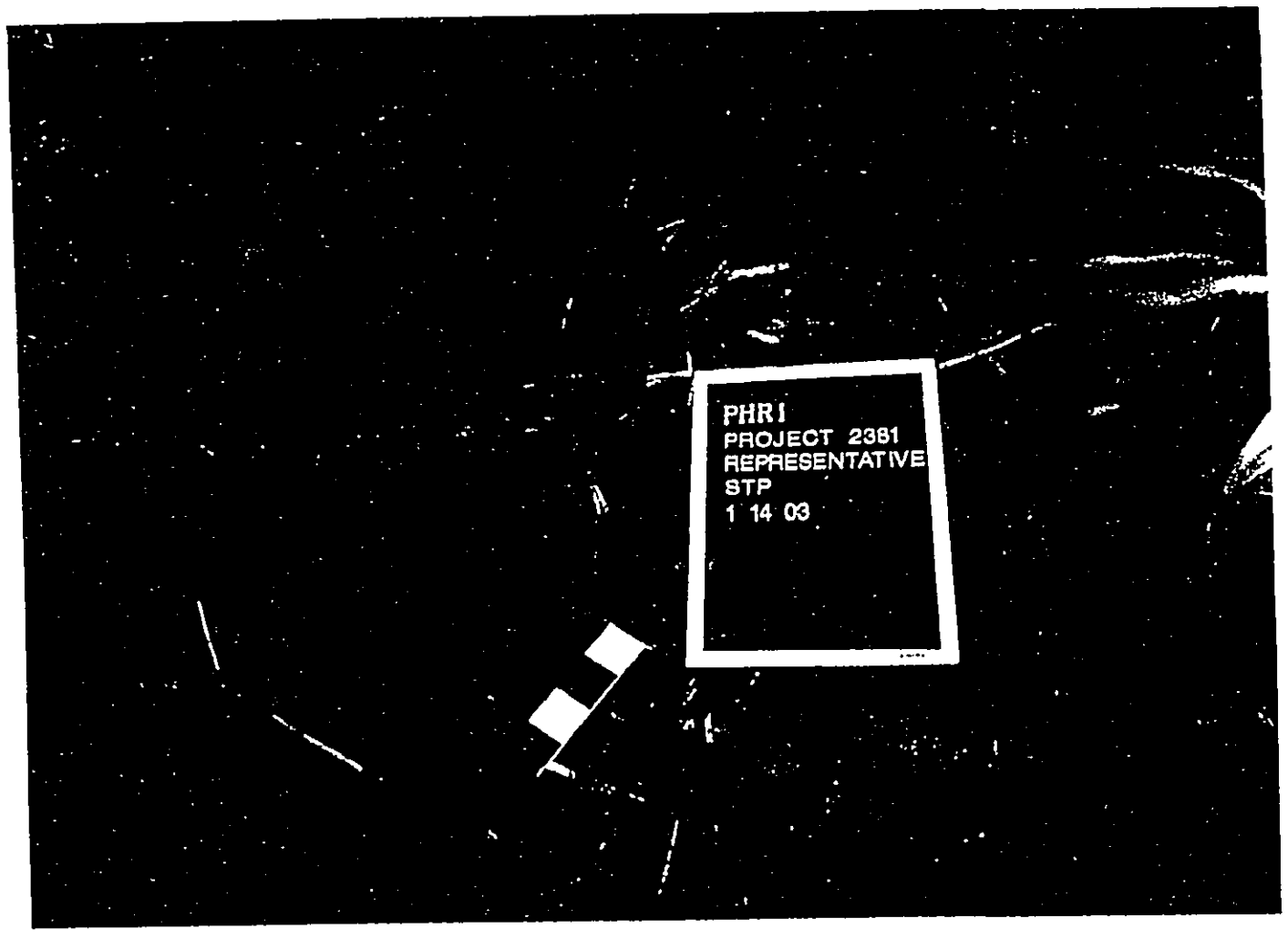
Figure 5. Representative STP (STP-1)



During the course of the excavations, several fragments of ceramics were found. Two fragments of a ceramic plate were found in STP-1, at a depth of 0.05-0.10 m. The two fragments were fit and glued together (*Figure 6*). Judging by condition and appearance, they may be from the early 20th century. Together the fragments measure 6.3 cm by 4.8 cm by 0.55 cm and weigh 19.24 grams.

Four fragments of a ceramic handle were recovered in STP-12, at a depth of c. 0.22 to 0.32 m. The fragments were also fit and glued together (*Figure 6*). Judging by condition and appearance, they also may be from the early 20th century. Together the fragments measure 14.66 cm by 7.64 cm by 2.59 cm and weigh 85.42 grams.

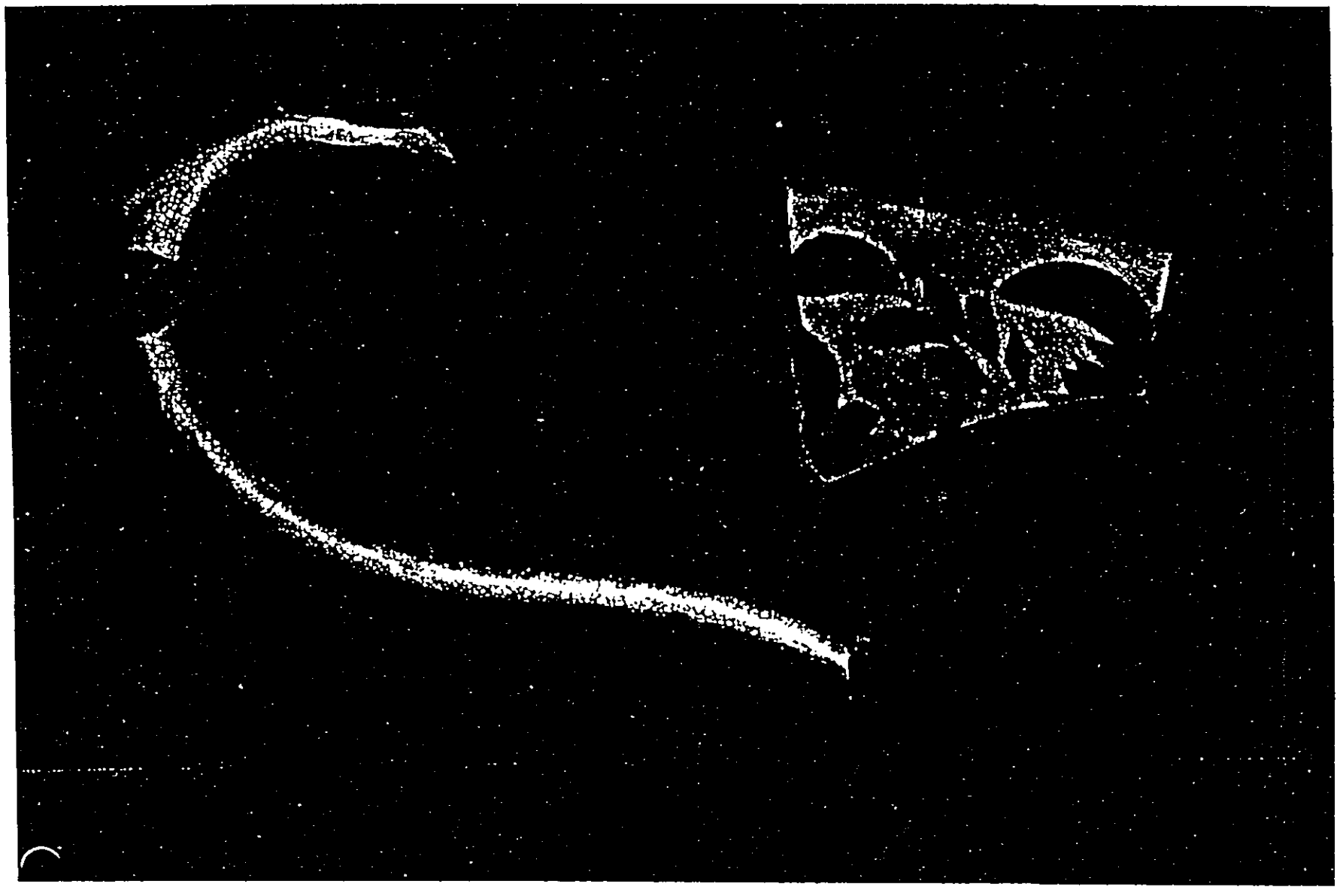


Figure 6. Ceramic Artifacts: Pitcher/vase Handle Fragments (left); Plate Fragments (right)

CONCLUSION

No significant archaeological or other cultural remains were found on the surface of the New Aviary project area. Based on an examination of the project area terrain and the findings of the STP excavations, it appears that the soil surrounding the aviaries is probably fill. The area of the aviaries has underlying bedrock that naturally slopes to the southeast; it appears that fill was brought in during initial construction in the area to level the area.

The two layers of soil found in the test units are very similar to each other. Perhaps they were deposited at one time and the differences are due to natural exposure, compaction, and moisture. Or perhaps the two layers represent different borrow areas.

The ceramics found in the STPs reflect the historic habitation that took place in the general area. According to Sean Callahan, the caretaker at HTBG, broken ceramic pieces are common in other nearby areas of the garden, and especially along the shore (pers. communication, January 14, 2004). Mr. Callahan also indicated that portions of the New Aviary project area had previously been a cage for flamingoes. Since it appears that the general area of the New Aviary has been filled, and the area has been disturbed in the process of constructing the botanical gardens, it is probable that the ceramics found are from a disturbed context.

During preparation of the Environmental Assessment for the current project area, Ms. Debra Ward of Moku Loa Group – Sierra Club raised the question of the possible existence of an ancient grave site beneath the current project site, claiming that sometime back in the 1980s someone informed her that this was the case. During the current surface and subsurface survey nothing remotely resembling a possible grave site was encountered. Based on the findings of the survey, it is our opinion that it is highly unlikely the project area contains graves. Perhaps the information given Ms. Ward was in reference to historic graves on the coastline (see page 3, paragraph 5; and *Figure 1*).

RECOMMENDATION

The detrimental effects of construction within the New Aviary project area has been mitigated by the pedestrian survey and STP excavation program. No further archaeological work is recommended in the project area, and it is recommended that an SHPD determination of "no historic properties affected" be granted (in accordance with the general guidance provided by Chapter 284: Section 5[b] of the SHPD Rules, HAR Title 13, DLNR; Subtitle 13).

REFERENCES CITED

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1983 *Atlas of Hawaii*. Honolulu: University of Hawaii Press. (Second edition)

Hudson, A.E.
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McGerty, L., and R.L. Spear
1995a Archaeological Inventory Survey of a Portion of Hawai'i Tropical Botanical Garden Onomea, South Hilo, Island of Hawai'i (TMK: 2-7-9: 02, 09, and 10). Prepared for Mr. Dan Lutkenhouse, Hawai'i Tropical Botanical Garden.

1995b Addendum to: Archaeological Inventory Survey of a Portion of Hawai'i Tropical Botanical Garden Onomea, South Hilo, Island of Hawai'i (TMK: 2-7-9: 02, 09, and 10). Prepared for Mr. Dan Lutkenhouse, Hawai'i Tropical Botanical Garden.

PHRI
1991a Archaeological Field Inspection Hawaii Tropical Botanical Garden Project Area Land of Onomea, South Hilo District Island of Hawaii (TMK:2-7-10:1,22). PHRI Letter Report No. 1032-051691. Prepared for Mr. Dan J. Lutkenhouse.

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LINDA LINGLE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
HISTORIC PRESERVATION DIVISION
KAKUHIHEWA BUILDING, ROOM 555
601 KAMOKILA BOULEVARD
KAPOLEI, HAWAII 96707

PETER T. YOUNG
CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT

DAN DAVIDSON
DEPUTY DIRECTOR - LAND

ERNEST Y.W. LAU
DEPUTY DIRECTOR - WATER

AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
BUREAU OF CONVEYANCES
COMMISSION ON WATER RESOURCE MANAGEMENT
CONSERVATION AND COASTAL LANDS
CONSERVATION AND RESOURCES ENFORCEMENT
ENGINEERING
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

February 26, 2004

Dr. Paul Rosendahl
PHRI
224 Waianuenue Avenue
Hilo, Hawaii 96720

LOG NO: 2004.0527
DOC NO: 0402JK24

Dear Rosendahl,

SUBJECT: Chapter 6E-42 Review of PHRI Report 2381-012804 "Historic Properties Assessment Survey, New Aviary Project, Hawai'i Tropical Botanical Garden Land of Onomea, South Hilo District"
TMK: (3) 2-7-009:002

Thank you for the opportunity to review and comment on the above referenced report, which was received in our Kona office on February 4, 2004. The report was prepared for Mr. Scott A. Lucas, administrator for Hawai'i Tropical Botanical Gardens, as a requirement for the processing of an Environmental Assessment (EA) and related Conservation District Use Permit (CDUP). The purpose of the assessment was to determine the presence and significance of any historic properties that might exist in the proposed project area and the need, if any, for mitigation. The overall objective of this work was to obtain a formal determination of "no historic properties affected" from our department.

The report presents the results of a 100% surface survey and subsurface testing of 13 shovel test probes in the vicinity of the existing birdcages at the Hawai'i Tropical Botanical Gardens. It is our understanding that an oral claim was made sometime in the 1980's of possible burials on the subject property and that special attention was given to locating remnants of possible graves during the assessment survey.

EXHIBIT 11

We believe that the archaeological assessment of the proposed project area was adequate. No historic properties were found in a survey of the property on January 14, 2004. You note that the area surrounding the existing aviaries is probably fill material on top of the underlying bedrock. Your report meets with our approval. We agree with your determination that "no historic properties will be affected" in the project area.

If any questions should arise about this project in the future, please contact our Hawaii Island archaeologist, Patrick McCoy at 692-8029.

Aloha,

P. Holly McElDowney

P. Holly McEldowney, Administrator
State Historic Preservation Division

JK:jen

c: Chris Yuen, County of Hawaii Planning Department
Kai Emler, County of Hawaii Department of Public Works
Kai Markell, Burial Sites Program
Chair, Hawai'i Island Burial Council

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2005 MAY 17 A 10:47
OFFICE OF CONSERVATION AND COASTAL LANDS

DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS

REF:OCCL:DH

FILE NO.: HA-3222

Acceptance Date: February 18, 2005
180-Day Exp. Date: August 17, 2005
Suspense Date: 21 Days from stamped date

APR 13 2005

MEMORANDUM

TO: Division of Forestry and Wildlife, Division of Conservation and Resources Enforcement, and Hawaii District Land Agent

FROM: Samuel J. Lemmo, Administrator

SUBJECT: REQUEST FOR COMMENTS
Conservation District Use Application (CDUA)
[DEPARTMENTAL Permit]

APPLICANT: Hawaii Botanical Tropical Garden

FILE NO.: HA-3222

REQUEST: Construct 800 Square Foot Aviary

LOCATION: South Hilo District, Island of Hawaii, TMK's: (3) 2-7-009:002, 006, 010 and (3) 2-7-010:022

PUBLIC HEARING: YES __ NO _X_

Attached please find a copy of the subject CDUA, and our Department's Notice of Acceptance. We would appreciate your review and comment on this CDUA by the suspense date noted above. We are including a copy of the Draft Environmental Assessment with this correspondence. If no response is received by the suspense date, we will assume there are no comments. Should you require additional information, please call Dawn Hegger of our Office of Conservation and Coastal Lands at 587-0380.

Attachment(s)

√ Comment all attached pp

( ) NO Comment

Signature

2005 MAY 16 P 3:21

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2005 MAY 13 PM 1:

DOCARE-1B | 3222-HA

HAWAII TROPICAL BOTANICAL GARDEN

SCOTT LUCAS, 964-5233

TMK: (3) 2-7-009-002, 006, 010 AND (3) 2-7-010-022

CONSTRUCTION OF AN 800 SQUARE FOOT AVIARY

APPLICANT IS PROPOSING TO DEMOLISH THREE EXISTING AVIARIES (APPROVED BY THE BLN HA-1447) AND CONSTRUCT A SINGLE LARGE AVIARY OCCUPYING ESSENTIALLY THE SAME SP SERVING THE SAME PURPOSE.

HAWAII | 4/15/2005

REVIEW THE ATTACHED APPLICATION AND COMMENT WITH RESPECT TO DOCARE'S CURRE PROGRAMS. NO SITE INSPECTION IS NEEDED. IF NO RESPONSE IS RECEIVED, LAND DIVISI ASSUME THAT THERE ARE NO COMMENTS

HA-05-079 | A. FORD

4-15-05 | 4-24

REVIEW OF CDUA INDICATES NO PROBLEM IS BELIEVED THAT THIS PROJECT WILL BE ENHANCEMENT TO THE AREA.

Exhibit 12

Hawaii Tropical Botanical Garden
A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781~ Web Site: www.htbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 ~ E-Mail: htbg@ilhawaii.net

May 27, 2005

Mr. A. Ford
Conservation and Resource Management
1151 Punchbowl St., Rm 220
Honolulu, HI 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Botanical Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-010:022

Dear Mr. Ford,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropical Botanical Garden's amendment to Conservation Use Permit HA-1447A, application HA-3222 for new Aviary. This letter address comments contained in your attachment report dated April 15, 2005.

Thank you so very much for responding favorably to the proposed Aviary project. You commented that the planned replacement would enhance the appearance of the site and contribute to the public's experience in the area; which, in addition to providing a better living environment for our Macaws, is why HTBG wishes to make this improvement.

Again, HTBG thanks you for your positive response. Your letter and this response will be appended to the final environmental assessment.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN
Kate Logan
Manager, Administration and Education

STATE OF HAWAII
Dept. Land & Natural Resources
Div. Conservation & Resources Enforcement
INVESTIGATION REPORT
DOCARE-6

1. Report Number: HA 05-0796
2. Investigator: A. FORD
Classification: LAND USE: CDUA
3. Island: Hawaii
4. District: S. Hilo, E. Hawaii
5. Complainant: State of Hawaii-OCCL
Address: 1151 Punchbowl St., Rm 220, Honolulu, HI
School, Employer: DLNR/OCCL
Bus. Ph: 587-0380
Location of offense: S. Hilo, Onomea TMK (3) 2-7-009-002, 006, 010 & 2-7-010-022
Date/time occurred: 04-15-05/1000/FRI
Date/time reported: 04-15-05/1000
Location of offense or type of premises: Commercial Tropical Garden

SYNOPSIS

DLNR/OCCL is requesting comments with regard to a CDUA to replace existing Aviaries. No site inspection is needed. Applicant is seeking to replace old, deteriorated aviaries with one new structure on the site in question.

DUA REVIEWED

4-24-05/0800 Hours. I reviewed the applicant's CDUA and attached documents. I have no comments at this time regarding the DUA. The planned replacement should enhance the appearance of the site and contribute to the public's experience in the are

DISPOSITION

It is recommended that this case be CLOSED: Records Only, and that a copy be routed to D. HEGGER at OCCL.

Report written by: Sean Ford | Badge No. 47 | Date/time: 04-28-05/1345

LINDA LINGLE
GOVERNOR OF HAWAII

GENEVIEVE E. Y. SALMONSON
DIRECTOR OF OEQC

In reply please refer to:
File:

STATE OF HAWAI'I
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
DEPARTMENT OF HEALTH
LEIOPAPA A KAMEHAMEHA
235 SOUTH BERETANIA STREET, SUITE 702
HONOLULU, HAWAI'I 96813
TELEPHONE (808) 586-4185

May 23, 2005

Mr. Scott A. Lucas
Hawaii Tropical Botanical Garden
P.O. Box 80
Papaikou, Hawai'i 96746

Mr. Samuel J. Lemmo
Office of Conservation and Coastal Lands
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawai'i 96809

Dear Messrs. Lucas and Lemmo:

The Office of Environmental Quality Control has reviewed your draft environmental assessment for the New Aviary at Hawai'i Tropical Botanical Garden, Tax Map Key No. 4th 4-2-22: 15, situated at Onomea Bay, in the judicial district of South Hilo, and offers the following comments for your consideration and response.

1. ***Riparian Resources***: Please include in the environmental assessment a topographical map showing the relation of the proposed aviary in relation to the streams and the coastline. This is necessary in order to analyze possible riparian and coastal impacts from runoff.
2. ***Cultural Impact Assessment and Sustainable Building Guidelines***: Please refer to cultural impact assessment guidance contained on our Internet website (*infra*). Also, please refer to the guidance on sustainable building contained in our Guidebook on the Internet at http://www.state.hi.us/health/oeqc/index.html.

Thank you for the opportunity to comment. If there are any questions, please call Mr. Leslie Segundo, Environmental Health Specialist, at (808) 586-4185.

Sincerely,

Genevieve Salmonson

GENEVIEVE SALMONSON
Director

Hawaii Tropical Botanical Garden
A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781 – Web Site: www.htbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 – E-Mail: htbg@ilhawaii.net

May 27, 2005

Genevieve Salmonson
State of Hawaii-OEQC Department of Health
235 South Bertenia Street, Suite 702
Honolulu, Hawaii 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Botanical Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-010:022

Dear Ms. Salmonson,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropical Botanical Garden's amendment to Conservation Use Permit HA-1447A, application HA-3222 for new Aviary. This letter addresses comments contained in your letter dated May 23, 2005.

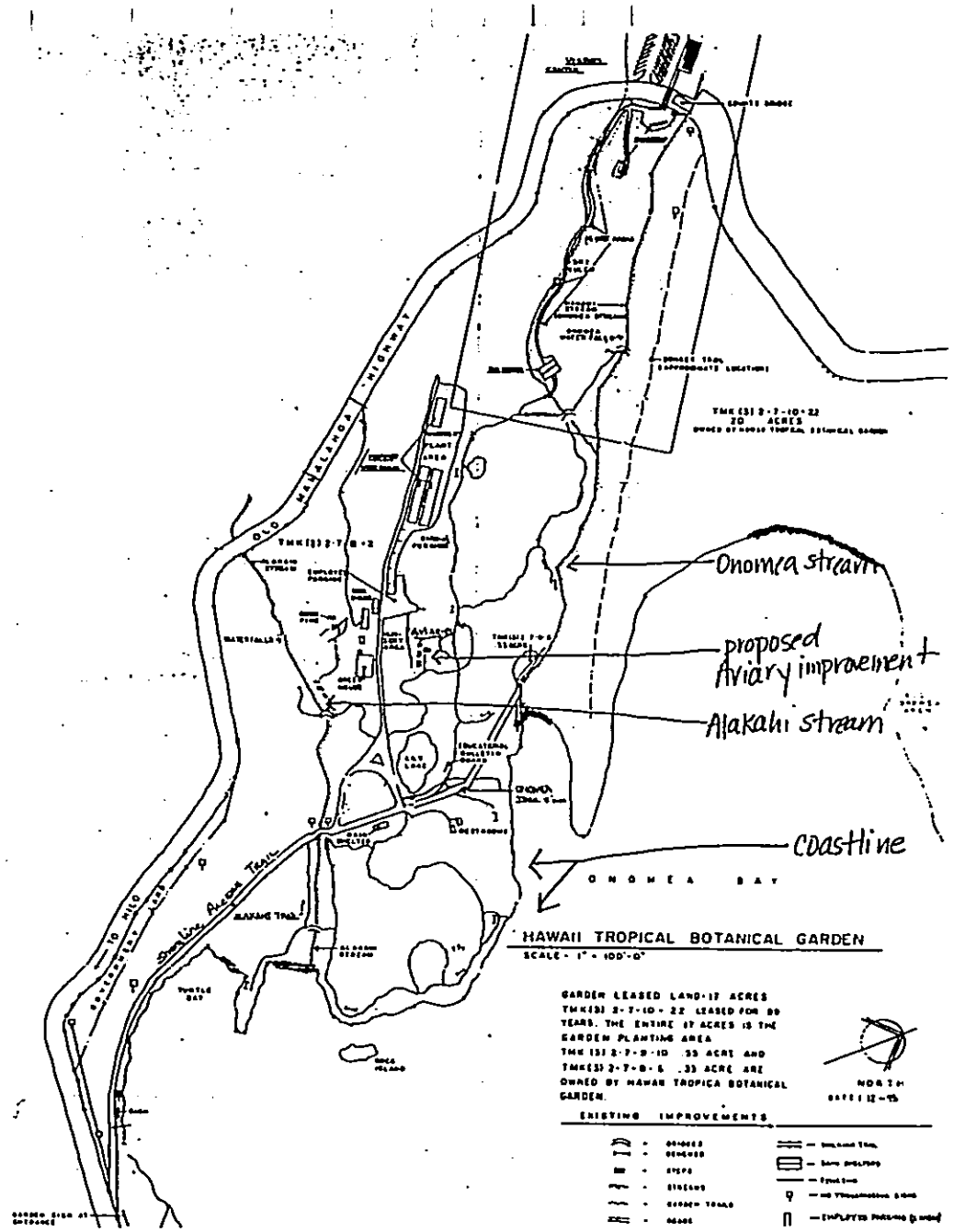
The Draft and Final Environmental Assessment(s), Exhibits 7 & 10 and the two maps accompanying this response show the relation of the proposed Aviary to the streams and the coastline. Currently, the three smaller enclosures which house Hawaii Tropical Botanical Garden's (HTBG) six Macaws are in the exact same location of the proposed improved Aviary. There is no runoff from the current enclosures nor will there be any runoff from the improvement into either stream or the ocean.

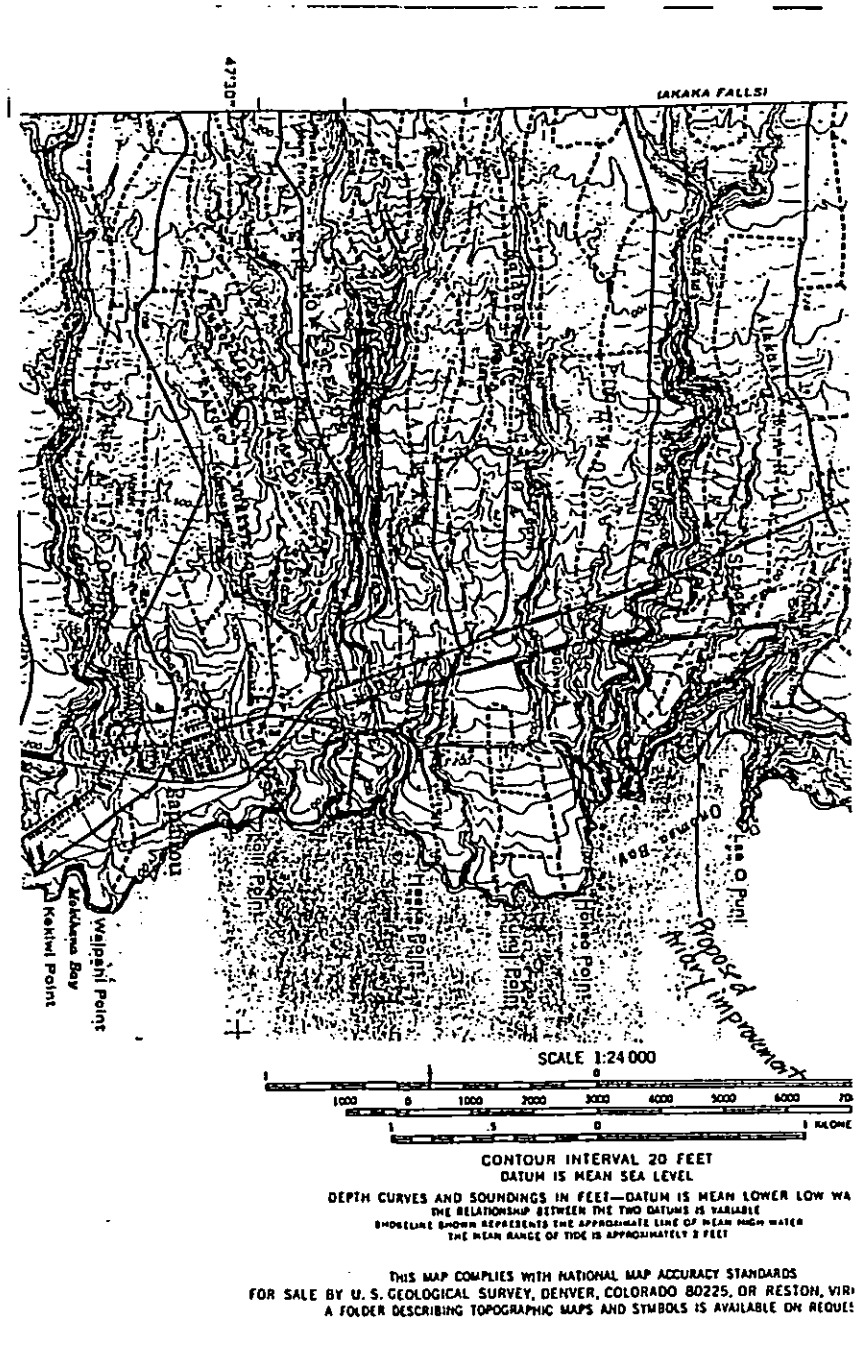
HTBG referred to recommended websites, cultural impact assessment guidance and guidance on sustainable building. We would like to thank you for the recommended resource and we will refer to the sites as needed.

We appreciate your comments on HTBG's draft environmental assessment. Your letter and this response will be appended to the final environmental assessment to ensure a document that adequately addresses pertinent issues.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN
Kate Logan
Kate Logan
Manager, Administration and Education


Onomea stream
proposed Aviary improvement
Alakahi stream
coastline
ONOMEA BAY
HAWAII TROPICAL BOTANICAL GARDEN
SCALE - 1" = 100'-0"
GARDEN LEASED LAND-17 ACRES
TMK(3) 2-7-10-22 LEASED FOR 99 YEARS. THE ENTIRE 17 ACRES IS THE GARDEN PLANTING AREA
TMK (3) 2-7-9-10 .55 ACRE AND
TMK(3) 2-7-9-5 .33 ACRE ARE OWNED BY HAWAII TROPICA BOTANICAL GARDEN.
EXISTING IMPROVEMENTS
NORTH
10 HILO
Scenic Shoreline Access Trail
MAKAHA TRAIL
TURTLE BAY


IAKAKA FALLS
Kakiwi Point
Waipahi Point
Hakalau Point
Proposed Aviary Improvement
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WA
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 2 FEET
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIR
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUE

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD05/1811

May 02, 2005

Samuel J. Lemmo
Department of Land and Natural Resources
Office of Conservation and Coastal Lands
Post Office Box 621
Honolulu, HI 96809

RE: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A for New Aviary at Hawaii Tropical Botanical Gardens, Pāpa'ikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002, 006, 101, (3) 2-7-010:022

Dear Mr. Lemmo,

The Office of Hawaiian Affairs (OHA) is in receipt of your April 14, 2005, request for comments on the above project, TMK: (3) 2-7-009:002, 006, 101, (3) 2-7-010:022. OHA offers the following comments.

Due of the extent of archaeological efforts, including subsurface exploration, within the proposed project area, further surveys are not warranted. Although construction activities will be completed without the use of heavy machinery, there is a possibly of encountering subsurface cultural deposits, including human burials related to the pre-contact village of Kahali'i. It is known that an historic cemetery, not within the bounds of proposed construction, is located within the Hawaii Tropical Botanical Garden (HTBG) lands. Limited debutage related to tool manufacture and the remains of soil retaining terraces have been located in previous archaeological studies and are testament to the depositional history of what is now part of the HTBG. Because excavations associated with the project are likely to disturb existing subsurface deposits, OHA recommends that all ground altering activities be monitored by a professional archaeologist.

It does not appear that a Cultural Impact Statement has been completed in support of the proposed HTBG expansion project. Information gathered through the Cultural Impact Statement process is crucial in understanding the context of potential cultural material finds. The

process is also necessary in understanding the nature and extent of Native Hawaiian during various stages of native and foreign land tenure.

The condition and stewardship of Onomea and Alakahi streams is of some concern t The past "unpermitted diversions" of both streams by HTBG have required interven treatment by the US Fish and Wildlife Service and the Hawaii State Division of Aqu Resources. Land and water use in a conservation district is regulated to uphold the it Hawaii's resources. OHA trusts that in the future all precautions will be taken to pro preserve the Onomea and Alakahi Streams, which are the fragile host to a variety of and endemic wildlife species.

OHA further requests your assurances that if the project goes forward, should iwi or Hawaiian cultural or traditional deposits be found during ground disturbance, work s and the appropriate agencies will be contacted pursuant to applicable law.

Thank you for the opportunity to comment. If you have further questions or concern contact Jesse Yorck at 594-1962 or jessey@oha.org.

'O wau iho nō,

Clyde W. Nāmu'o
Administrator

Hawaii Tropical Botanical Garden
A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781~ Web Site: www.htbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 ~ E:Mail: htbg@ilhawaii.net

May 27, 2005

Clyde W. Nāmu'o, Administrator
State of Hawaii-Office of Hawaiian Affairs
711 Kapi'olani Boulevard, Suite 500
Honolulu, Hawai'i 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Botanical Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-010:022

Dear Mr. Nāmu'o,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropical Botanical Garden's amendment to Conservation Use Permit HA-1447A, application HA-3222 for new Aviary. This letter addresses comments contained in your letter dated May 2, 2005.

Hawaii Tropical Botanical Garden (HTBG) understands your concerns regarding subsurface cultural deposits related to the pre-contact village of Kahali'i. The proposed new Aviary requires no subsurface construction. The only "groundwork" required for the proposed Aviary is the placement of several 1'wide by 1' deep footings. Your recommendation to have all ground altering activities monitored is noted.

Presently HTBG's six Macaws are housed in three separate enclosures. The draft environmental assessment outlines an improvement to an existing structure, rather than a new construction project. The proposal requests permission to erect one enclosure, in the same exact location, which would allow our six Macaws to live in one unit rather than three separate smaller ones.

HTBG is a non-profit educational institution that respects and understands the queries raised in your response letter. The history and cultural significance of Onomea Valley are protected and perpetuated by the staff and policies of the Garden today.

We appreciate your comments on HTBG's draft environmental assessment. Y and this response will also be appended to the final environmental assessment document that adequately addresses pertinent issues.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN
Kate Logan
Manager, Administration and Education

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS

REF:OCCL:DH

FILE NO.: HA-3222

Acceptance Date: February 18, 2005
180-Day Exp. Date: August 17, 2005
Suspense Date: 21 Days from stamped date

APR 13 2005

MEMORANDUM

TO: Division of Forestry and Wildlife, Division of Conservation and Resources Enforcement, and Hawaii District Land Agent

FROM: Samuel J. Lemmo, Administrator

RECEIVED
OFFICE OF CONSERVATION
AND COASTAL LANDS
DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII
2005 APR 15 P 2:53

SUBJECT: REQUEST FOR COMMENTS
Conservation District Use Application (CDUA)
[DEPARTMENTAL Permit]

APPLICANT: Hawaii Botanical Tropical Garden

FILE NO.: HA-3222

REQUEST: Construct 800 Square Foot Aviary

LOCATION: South Hilo District, Island of Hawaii, TMK's: (3) 2-7-009:002, 006, 010 and (3) 2-7-010:022

PUBLIC HEARING: YES __ NO _X_

Attached please find a copy of the subject CDUA, and our Department's Notice of Acceptance. We would appreciate your review and comment on this CDUA by the suspense date noted above. We are including a copy of the Draft Environmental Assessment with this correspondence. If no response is received by the suspense date, we will assume there are no comments. Should you require additional information, please call Dawn Hegger of our Office of Conservation and Coastal Lands at 587-0380.

Attachment(s)

( ) Comment

(X) NO Comment

Signature

PAUL J. CONRY, ADMINISTRATOR
DIVISION OF FORESTRY AND WILDLIFE
APR 13 2005

Hawaii Tropical Botanical Garden
A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781 ~ Web Site: www.htbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 ~ E:Mail: htbg@ilhawaii.net

May 27, 2005

Mr. Paul J. Conry, Administrator
Division of Forestry and Wildlife
1151 Punchbowl St., Rm 325
Honolulu, HI 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Use Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Botanica Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-010:0

Dear Mr. Conry,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropical Botanical Garden's amendment to Conservation Use Permit HA-1447A, application H 3222 for new Aviary. This letter acknowledges that you checked the no comment box

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN

Kate Logan
Manager, Administration and Education

Harry Kim
Mayor

Christopher J. Yuen
Director

Roy R. Takemoto
Deputy Director

County of Hawaii
PLANNING DEPARTMENT
101 Pauahi Street, Suite 3 • Hilo, Hawaii 96720-3043
(808) 961-8288 • Fax (808) 961-8742

May 2, 2005

RECEIVED
OFFICE OF CONSERVATION
AND COASTAL LANDS
2005 MAY -5 P 4:17
DEPT. OF LAND &
NATURAL RESOURCES
STATE OF HAWAII

Mr. Samuel J. Lemmo
Administrator
Department of Land and Natural Resources
Office of Conservation and Coastal Lands
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Lemmo:

Subject: Conservation District Use Application HA-3222
Applicant: Hawaii Tropical Botanical Garden
Land Owners: Hawaii Tropical Botanical Garden
Project: Construction of a 800-square foot aviary
Tax Map Key: (3) 2-7-009-002, 006, 010 & 2-7-010:022

We have reviewed the subject CDUA and the attached Draft Environmental Impact Statement (DEIS) for the proposed project and have no additional comments to those provided in our previous letters to the applicant identified as Exhibits 1 and 4 in the DEIS.

We appreciate being provided an opportunity to review and comment on the proposed project. Should you have questions, please feel welcome to contact Larry Brown or Esther Imamura of my staff at 961-8288.

Sincerely,

CHRISTOPHER J. YUEN
Planning Director

LMB:cd
P:\WPWIN60\Larry\DLNR Correspondence\Lemmo-HTBG CDUA2-7-9-2.doc

Hawai'i County is an equal opportunity provider and employer

Hawaii Tropical Botanical Garden

A Non-Profit 501(c)(3) Scientific and Educational Corporation
Nature Preserve and Sanctuary located at Onomea Bay
P. O. Box 80 • Papaikou, Hawai'i 96781– Web Site: www.hbg.com
Tel: (808) 964-5233 • Fax (808) 964-1338 ~ E:Mail: hbg@ilhawaii.net

May 27, 2005

Mr. Christopher J. Yuen, Planning Director
County of Hawaii-Planning Department
101 Pauahi Street, Suite 3
Hilo, Hawaii 96720-3043

Re: Draft Environmental Assessment for Amendment to Conservation District Us
Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Bota
Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-0

Dear Mr. Yuen,

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropica
Botanical Garden's amendment to Conservation Use Permit HA-1447A, applicati
3222 for new Aviary. This letter acknowledges that you have no additional comm
those provided in previous letters.

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN
Kate Logan
Manager, Administration and Education

4-20-05; 1:58PM; SOH DLNR HILO

1808 974 6222

RECEIVED
OFFICE OF CONSERVATION
2005 APR 20 P 3:03

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS

REF:OCCL:DH

FILE NO.: HA-3222

DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

Acceptance Date: February 18, 2005
180-Day Exp. Date: August 17, 2005
Suspense Date: 21 Days from stamped date

APR 13 2005

MEMORANDUM

TO: Division of Forestry and Wildlife, Division of Conservation and Resources Enforcement, and Hawaii District Land Agent

FROM: Samuel J. Lemmo, Administrator

SUBJECT: REQUEST FOR COMMENTS
Conservation District Use Application (CDUA)
[DEPARTMENTAL Permit]

RECEIVED
LAND DIVISION
HILO, HAWAII
2005 APR 14 P 2:18

APPLICANT: Hawaii Botanical Tropical Garden

FILE NO.: HA-3222

REQUEST: Construct 800 Square Foot Aviary

LOCATION: South Hilo District, Island of Hawaii, TMK's: (3) 2-7-009:002, 006, 010 and (3) 2-7-010:022

PUBLIC HEARING: YES__ NO_X_

Attached please find a copy of the subject CDUA, and our Department's Notice of Acceptance. We would appreciate your review and comment on this CDUA by the suspense date noted above. We are including a copy of the Draft Environmental Assessment with this correspondence. If no response is received by the suspense date, we will assume there are no comments. Should you require additional information, please call Dawn Hegger of our Office of Conservation and Coastal Lands at 587-0380.

Attachment(s)

( ) Comment

(✓) NO Comment

Signature

Hawaii Tropical Botanical Garden
A Non-Profit 501(c)(3) Scientific and Educational Corporation
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Tel: (808) 964-5233 • Fax (808) 964-1338 – E:Mail: htbg@ilhawaii.n

May 27, 2005

Hawaii District Land Agent
1151 Punchbowl St.
Honolulu, HI 96813

Re: Draft Environmental Assessment for Amendment to Conservation District Permit HA-1447A, application HA-3222 for New Aviary at Hawaii Tropical Bc Garden, Papaikou, South Hilo, Hawaii, TMK: (3) 2-7-009:002,006,101, (3) 2-7-

Thank you for reviewing the Draft Environmental Assessment for Hawaii Tropi Botanical Garden's amendment to Conservation Use Permit HA-1447A, applic 3222 for new Aviary. This letter acknowledges that you checked the no comm

Sincerely,

HAWAII TROPICAL BOTANICAL GARDEN
Kate
Kate Logan
Manager, Administration and Education