

# Report on West Wailua Iki Stream Maui, Hawai'i



**August 2009**

State of Hawai'i  
Department of Land and Natural Resources  
**Division of Aquatic Resources**

and

**Bishop Museum**





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# **Report on Wailua Iki West Stream Maui, Hawai‘i**

**August 2009**

Prepared for  
Commission on Water Resource Management  
Department of Land and Natural Resources  
State of Hawai‘i

Prepared by  
Division of Aquatic Resources<sup>1</sup>  
Department of Land and Natural Resources  
State of Hawai‘i  
and  
Bishop Museum<sup>2</sup>

## **Authors:**

Glenn Higashi<sup>1</sup>, James Parham<sup>2</sup>, Skippy Hau<sup>1</sup>, Robert Nishimoto<sup>1</sup>, Eko Lapp<sup>1</sup>, Darrell Kuamo‘o<sup>1</sup>, Lance Nishiura<sup>1</sup>, Tim Shindo<sup>1</sup>, Troy Sakihara<sup>1</sup>, Troy Shimoda<sup>1</sup>, and Dan Polhemus<sup>1</sup>



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## Section 1: Introduction

### Overview

On May 24, 2001, the Native Hawaiian Legal Corporation (NHLC) filed a Petition to Amend the Interim Instream Flow Standard (IIFS) for 27 streams in east Maui on behalf of resident taro farmers. Since the acceptance of the petitions in July 2001, the Commission on Water Resource Management (CWRM) has been focused on gathering information for the 27 petitioned streams. Shortly thereafter, NHLC and CWRM staff reached an agreement that efforts would focus on 8 of the 27 petitioned streams: Honopou, Hanehoi, Huelo, Waiokamilo, Kualani, Pi'ina'au, Palauhulu, and Wailua Nui Streams. Currently, the CWRM is collaborating with the State's Division of Aquatic Resources and the U.S. Geological Survey (USGS) for assistance in collecting biological and hydrologic data to determine measurable interim IFS. CWRM has also requested biological data on the remaining 19 petitioned streams which is the main purpose of this report.

This report is an accounting of the aquatic resources that have been observed in Wailua Iki West Stream, Maui from the year 2000 to the present. The focus of this report is on the animals and insects that live in the stream and the data collected during surveys. The report covers five main sections, including:

- Introduction
- Watershed Atlas Report
- DAR Point Quadrat Survey Report
- DAR Estuary Survey Report
- Photographs of stream taken during stream surveys

The introduction provides the overview for the purpose of this report, a summary of the findings on the stream and its animals, and a discussion of the importance of the findings and how stream conditions influence native species populations. The Watershed Atlas Report provides a description of the watershed and its aquatic resources from Division of Aquatic Resources (DAR) and other published/unpublished surveys, including a rating of the condition of the stream compared to other streams on Maui as well as statewide. The DAR Point Quadrat Survey Report describes the distribution, habitats, and species observed during the standardized DAR stream surveys. The DAR Estuary Survey Report describes the distribution, habitats, and species observed in the estuary during the standardized DAR estuary surveys. Finally, the photographs provide context to the conditions that the stream surveyors encountered in the stream.

This overview reports on the highlights of these findings and provides a discussion of the importance of the information presented. We hope that this format provides the reader with a simplified, general discussion and understanding of the conditions of Wailua Iki West Stream while also providing substantial evidence to support the conclusions presented.

## Findings for Wailua Iki West Stream, Maui

Wailua Iki West is a small watershed (4.1sq miles). It is mostly zoned for conservation (97.7%) and agriculture (0.3%). The land cover is mostly evergreen forest (79%), scrub (16%), grassland (4%) and bare land (2%). Numerous stream surveys of different types have been completed in Wailua Iki West Stream beginning in 1962 to the present. This watershed rates high, based on the data contained in the DAR aquatic surveys database, in comparison to other watersheds in Maui and statewide. It has a total watershed rating of 7 out of 10, a total biological rating of 7 out of 10, and a combined overall rating of 8 out of 10.

Native species observed in the stream include the following categories and species:

Fish - *Awaous guamensis*, *Eleotris sandwicensis*, *Lentipes concolor*, *Kuhlia* sp., *Kuhlia xenura* and *Sicyopterus stimpsoni*.

Crustaceans - *Atyoida bisulcata*, *Metopograpsus thukuhar*

Insect – *Telmatogen* sp.

Mollusks - *Ferrissia sharpi*, *Neritina granosa*

Sponge - *Heteromeyenia baileyi*

Introduced species observed in this stream includes the following categories and species:

Amphibian – *Rana catesbiana*, *Rana rugosa*, *Ranid* sp.

Crustaceans - *Macrobrachium lar*

Fish – *Tilapia* sp.

Mollusks - *Lymnaeid* sp, *Physid* sp., *Pomacea paludosa*

## Discussion

Wailua Iki West watershed is narrow and steep with a small embayment at the stream mouth which it shares with the Wailua Iki East watershed (Figure 5-2).

The physical characteristics of Wailua Iki West estuary matched that of Wailua Iki East. It flows into an unprotected coastal embayment with relatively calm, clear and shallow waters. The stream mouth was open (Figure 5-3) with moderate flow entering the bay with salinity ranging from 0.29 ppt to 32.94 ppt throughout the estuary. The shoreline consisted of mainly boulder and cobble terrain. Water conditions were relatively calm, but no detritus was observed as it was in the eastern section of the embayment (Wailua Iki East).

Estuary surveys were conducted at low tide in the morning and at high tide in the afternoon in the estuary reach of Wailua Iki West (Figure 5-4). Cast net sampling resulted in a total catch of 34 fish and invertebrates consisting of three species of fish and one invertebrate species in the estuary. The most dominant species in our sample was **āholehole**, *Kuhlia xenura* (n=18), which were recorded mainly at the stream mouth in lower salinities. **Hawaiian surf fish**, *Iso hawaiiensis* was recorded in higher salinity water at high tide along the shoreline. A single

mullet, **uouoa**, *Neomyxus leuciscus*, was recorded at one site near the mouth of Wailua Iki West stream. One species of shrimp, **tiger shrimp**, *Palaemon pacificus*, was recorded in detritus on the east side of the estuary.

The abundance of *K. xenura* in the estuary and lower reaches of Wailua Iki West Stream may serve as an indicator of flow and a measure of the health of the stream. Our data has shown that *K. xenura* were commonly found in estuaries with flowing streams that had open stream mouths and was the most dominant species in those estuaries. Compared to other estuaries that were surveyed in East Maui, Wailua Iki West may provide a more suitable habitat for juvenile and adult estuarine species. This is based on the physical characteristics of the estuary that were described as well as the presence of key species indicating favorable estuarine conditions such as *K. xenura*.

Point quadrat surveys were conducted in the lower, middle, and upper reaches. The upper reach by Hāna Highway was not surveyed, but the upper reach was surveyed above the diversion. There was moderate stream flow above the diversion.

In the lower reaches *K. xenura* and **hīhīwai** (*Neritina granosa*) were observed at water temperatures of 20.9° C; in the middle reach **‘o‘opu nōpili** (*Sicyopterus stimpsoni*) and *N. granosa* were observed at water temperatures of 22.1° C; and the upper reach was completely dominated by **‘ōpae kala‘ole** (*Atyoida bisulcata*) with water temperatures of 15.9° C which is probably an indicator that the reach is being spring-fed.

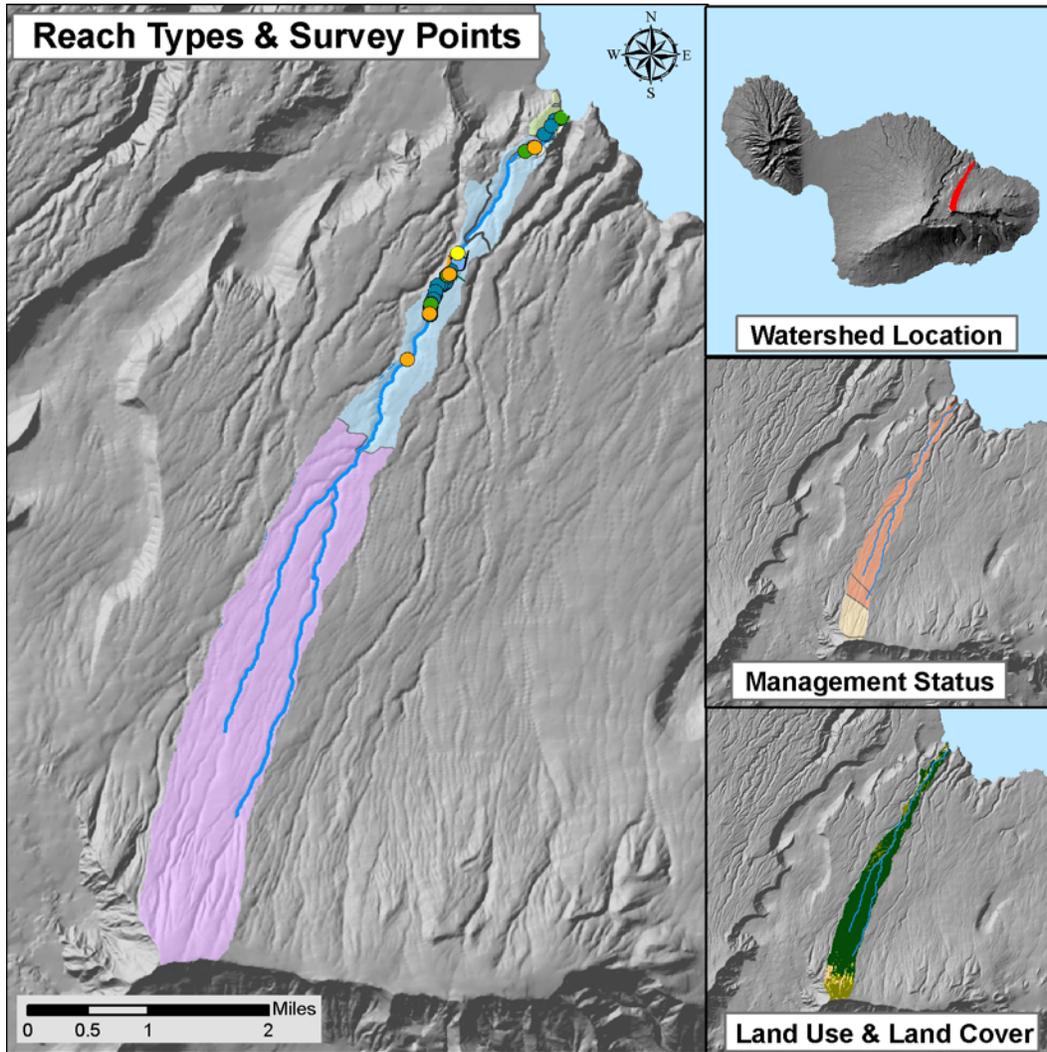
Overall, Wailua Iki West Stream has good potential stream habitat in the lower, middle, and upper reaches, but the majority of habitat was lost to water withdrawal. Restoration of flow downstream would therefore improve animal passage between diversions upstream and downstream and substantially increase the availability of habitat for native stream species. Restoration of flow and improvement of animal passage would have the greatest effect on *S. stimpsoni* and *A. bisulcata*, and would further enhance the overall productivity of Wailua Iki West Stream.

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## Section 2: Watershed Atlas

*DAR Watershed Code: 64015*

### Wailua Iki West, Maui



### Watershed Features

Wailua Iki West watershed occurs on the island of Maui. The Hawaiian meaning of the name is small Wailua. The area of the watershed is 4.1 square mi (10.7 square km), with maximum elevation of 8839 ft (2694 m). The watershed's DAR cluster code is not yet determined. The percent of the watershed in the different land use districts is as follows: 0.3% agricultural, 99.7% conservation, 0% rural, and 0% urban.

**Land Stewardship: Percentage of the land in the watershed managed or controlled by the corresponding agency or entity. Note that this is not necessarily ownership.**

<u>Military</u>	<u>Federal</u>	<u>State</u>	<u>OHA</u>	<u>County</u>	<u>Nature Conservancy</u>	<u>Other Private</u>
0.0	1.2	79.0	0.0	0.0	19.2	0.6

**Land Management Status: Percentage of the watershed in the categories of biodiversity protection and management created by the Hawaii GAP program.**

<u>Permanent Biodiversity Protection</u>	<u>Managed for Multiple Uses</u>	<u>Protected but Unmanaged</u>	<u>Unprotected</u>
20.4	79.0	0.0	0.6

**Land Use: Areas of the various categories of land use. These data are based on NOAA C-CAP remote sensing project.**

	<u>Percent</u>	<u>Square mi</u>	<u>Square km</u>
High Intensity Developed	0.0	0.00	0.00
Low Intensity Developed	0.0	0.00	0.00
Cultivated	0.0	0.00	0.00
Grassland	3.9	0.16	0.42
Scrub/Shrub	15.9	0.66	1.70
Evergreen Forest	78.6	3.24	8.39
Palustrine Forested	0.0	0.00	0.00
Palustrine Scrub/Shrub	0.0	0.00	0.00
Palustrine Emergent	0.0	0.00	0.00
Estuarine Forested	0.0	0.00	0.00
Bare Land	1.5	0.06	0.16
Unconsolidated Shoreline	0.0	0.00	0.00
Water	0.1	0.00	0.01
Unclassified	0.0	0.00	0.00

**Stream Features**

Wailua Iki West is a perennial stream. Total stream length is 9.4 mi (15.1 km). The terminal stream order is 2.

**Reach Type Percentages: The percentage of the stream's channel length in each of the reach type categories.**

<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
0.0	1.8	5.2	31.7	61.3

The following stream(s) occur in the watershed:

Wailua Iki West

## Biotic Sampling Effort

Biotic samples were gathered in the following year(s):

1962      1990      1994      2003      2008      2009

**Distribution of Biotic Sampling: The number of survey locations that were sampled in the various reach types.**

<u>Survey type</u>	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
Damselfly Surveys	0	0	0	3	0
DAR Point Quadrat	0	3	3	36	0
DAR Rapid BioAssessment	0	0	0	1	0
HDFG	0	0	1	3	0
Published Report	0	1	1	3	0

## Biota Information

### Species List

#### **Native Species**

<b>Crustaceans</b>	<i>Atyoida bisulcata</i>
	<i>Metopograpsus thukuhar</i>
<b>Fish</b>	<i>Awaous guamensis</i>
	<i>Eleotris sandwicensis</i>
	<i>Kuhlia</i> sp.
	<i>Kuhlia xenura</i>
	<i>Lentipes concolor</i>
	<i>Sicyopterus stimpsoni</i>
<b>Snails</b>	<i>Ferrissia sharpi</i>
	<i>Neritina granosa</i>
<b>Sponges</b>	<i>Heteromeyenia baileyi</i>

#### **Native Species**

<b>Insects</b>	<i>Anax strenuus</i>
	<i>Campsicnemus lepidochaites</i>
	<i>Campsicnemus</i> sp.
	<i>Dasyhelea hawaiiensis</i>
	<i>Hyposmocoma</i> sp
	<i>Megalagrion blackburni</i>
	<i>Megalagrion calliphya</i>
	<i>Megalagrion hawaiiense</i>
	<i>Megalagrion</i> sp.
	<i>Procanace acuminata</i>
	<i>Procanace confusa</i>
	<i>Procanace constricta</i>
	<i>Rhantus pacificus</i>
	<i>Saldula exulans</i>
	<i>Scatella cilipes</i>
	<i>Scatella clavipes</i>
	<i>Scatella femoralis</i>
	<i>Scatella mauiensis</i>
	<i>Scatella oahuense</i>

*Telmatogeton abnormis*

*Telmatogeton sp.*

*Telmatogeton torrenticola*

**Introduced Species**

**Amphibians** *Rana catesbiana*

*Rana rugosa*

Ranid sp.

**Crustaceans** *Macrobrachium lar*

**Fish** *Tilapia sp.*

**Snails** Lymnaeid sp.

Physid sp.

*Pomacea paludosa*

**Introduced Species**

**Insects** *Cheumatopsyche analis*

Chironomid sp.

*Cricotopus bicinctus*

*Dolichopus exsul*

*Hydroptila potosina*

*Limonia advena*

*Sepedon aenescens*

**Species Size Data: Species size (inches) observed in DAR Point Quadrat Surveys.**

<u>Scientific Name</u>	<u>Status</u>	<u>Minimum Size</u>	<u>Maximum Size</u>	<u>Average Size</u>
<i>Rana rugosa</i>	Introduced	1	2.5	2.3
Ranid sp.	Introduced	2	2	2.0
<i>Atyoida bisulcata</i>	Endemic	1	2	1.3
<i>Macrobrachium lar</i>	Introduced	3	4	3.3
<i>Eleotris sandwicensis</i>	Endemic	5	5	5.0
<i>Kuhlia xenura</i>	Endemic	1.25	3	2.5
<i>Sicyopterus stimpsoni</i>	Endemic	1.25	4	2.9
<i>Awaous guamensis</i>	Indigenous	3	5	3.7
<i>Telmatogeton sp.</i>	Indigenous	0.5	0.75	0.6
<i>Neritina granosa</i>	Endemic	1	1.5	1.2
Physid sp.	Introduced	0.125	0.125	0.1

**Average Density: The densities (#/square yard) for species observed in DAR Point Quadrat Surveys averaged over all sample dates in each reach type.**

<u>Scientific Name</u>	<u>Status</u>	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
<i>Atyoida bisulcata</i>	Endemic				14.7	
<i>Eleotris sandwicensis</i>	Endemic			0.57		
<i>Kuhlia xenura</i>	Endemic		3.04	2.3		
<i>Neritina granosa</i>	Endemic		7.61	1.15		
<i>Sicyopterus stimpsoni</i>	Endemic			4.02		
<i>Awaous guamensis</i>	Indigenous			2.87		

<i>Telmatogeton</i> sp.	Indigenous	0.31
<i>Macrobrachium</i> lar	Introduced	2.87
Physid sp.	Introduced	0.08
<i>Rana rugosa</i>	Introduced	0.47
Ranid sp.	Introduced	0.16

**Species Distributions: Presence (P) of species in different stream reaches.**

<u>Scientific Name</u>	<u>Status</u>	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
<i>Atyoida bisulcata</i>	Endemic			P	P	
<i>Eleotris sandwicensis</i>	Endemic			P		
<i>Kuhlia xenura</i>	Endemic		P	P		
<i>Lentipes concolor</i>	Endemic		P	P		
<i>Sicyopterus stimpsoni</i>	Endemic			P		
<i>Anax strenuus</i>	Endemic				P	
<i>Campsicnemus</i> sp.	Endemic				P	
<i>Dasyhelea hawaiiensis</i>	Endemic				P	
<i>Hyposmocoma</i> sp	Endemic				P	
<i>Megalagrion blackburni</i>	Endemic				P	
<i>Megalagrion calliphya</i>	Endemic				P	
<i>Megalagrion hawaiiense</i>	Endemic				P	
<i>Megalagrion</i> sp.	Endemic			P	P	
<i>Procanace acuminata</i>	Endemic				P	
<i>Procanace confusa</i>	Endemic				P	
<i>Procanace constricta</i>	Endemic				P	
<i>Rhantus pacificus</i>	Endemic				P	
<i>Saldula exulans</i>	Endemic				P	
<i>Scatella cilipes</i>	Endemic				P	
<i>Scatella clavipes</i>	Endemic				P	
<i>Scatella femoralis</i>	Endemic				P	
<i>Scatella mauiensis</i>	Endemic				P	
<i>Scatella oahuense</i>	Endemic				P	
<i>Telmatogeton abnormis</i>	Endemic				P	
<i>Telmatogeton torrenticola</i>	Endemic				P	
<i>Ferrissia sharpi</i>	Endemic				P	
<i>Neritina granosa</i>	Endemic				P	P
<i>Metopograpsus thukuhar</i>	Indigenous				P	

<i>Awaous guamensis</i>	Indigenous	P	P
<i>Kuhlia</i> sp.	Indigenous	P	
<i>Campsicnemus</i> sp.	Indigenous		P
<i>Telmatogeton</i> sp.	Indigenous		P
<i>Heteromeyenia baileyi</i>	Indigenous		P
<i>Rana catesbiana</i>	Introduced		P
<i>Rana rugosa</i>	Introduced		P
<i>Macrobrachium lar</i>	Introduced	P	P
<i>Cheumatopsyche analis</i>	Introduced		P
<i>Cricotopus bicinctus</i>	Introduced		P
<i>Dolichopus exsul</i>	Introduced		P
<i>Hydroptila potosina</i>	Introduced		P
<i>Limonia advena</i>	Introduced		P
<i>Sepedon aenescens</i>	Introduced		P
Lymnaeid sp.	Introduced		P

### Historic Rankings

**Historic Rankings: These are rankings of streams from historical studies. "Yes" means the stream was considered worthy of protection by that method. Some methods include non-biotic data in their determination. See Atlas Key for details.**

Multi-Attribute Prioritization of Streams - Potential Heritage Streams (1998): No

Hawaii Stream Assessment Rank (1990): Moderate

U.S. Fish and Wildlife Service High Quality Stream (1988): No

The Nature Conservancy- Priority Aquatic Sites (1985): No

National Park Service - Nationwide Rivers Inventory (1982): No

**Current DAR Decision Rule Status: The following criteria are used by DAR to consider the biotic importance of streams. "Yes" means that watershed has that quality.**

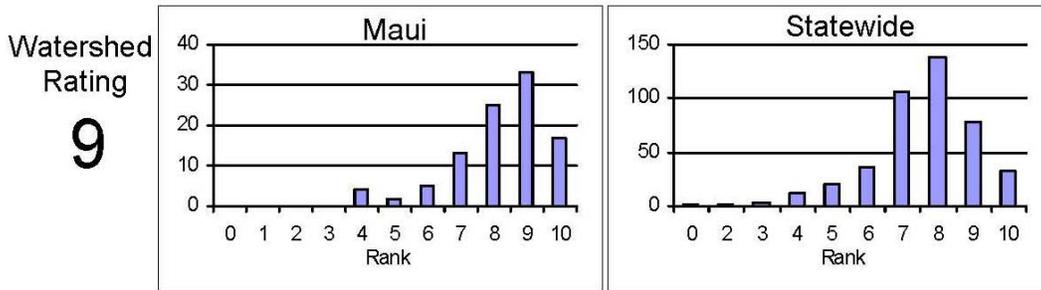
Native Insect Diversity <u>&gt; 19 spp.</u>	Native Macrofauna <u>Diversity &gt; 5 spp.</u>	Absence of Priority 1 <u>Introduced</u>
Yes	Yes	No
Abundance of Any <u>Native Species</u>	Presence of Candidate <u>Endangered Species</u>	Endangered Newcomb's <u>Snail Habitat</u>
No	No	No

### CURRENT WATERSHED AND STREAM RATINGS

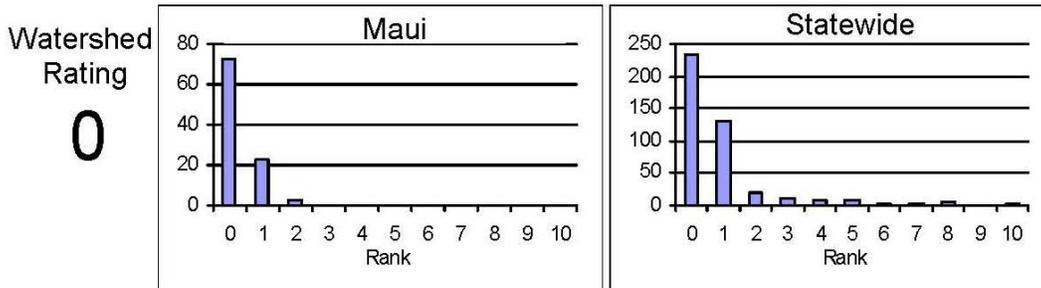
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding of the meaning of a particular ranking and how it compares to other streams. The ratings are standardized to range from 0 to 10 (0 is lowest and 10 is highest rating) for each variable and the totals are also standardized so that the rating is not the average of each component rating. These ratings are subject to change as more data are entered into the DAR Aquatic Surveys Database and can be automatically recalculated as the data improve. In addition to the ratings, we have also provided an estimate of the confidence level of the ratings. This is called rating strength. The higher the rating strength the more likely the data and rankings represent the actual condition of the watershed, stream, and aquatic biota.

#### WATERSHED RATING: Wailua Iki West, Maui

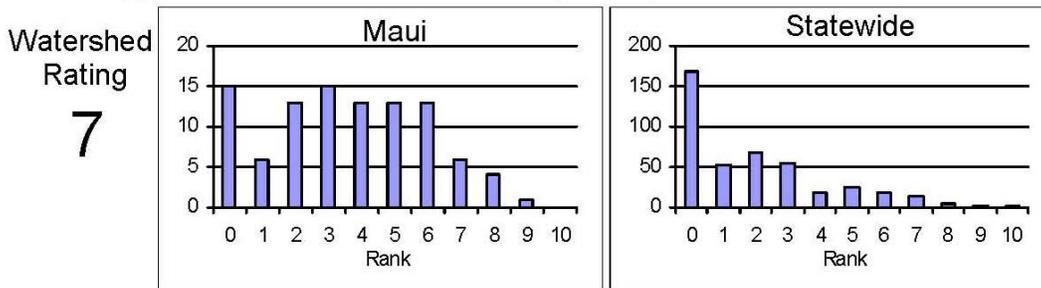
Land Cover Rating: Rating is based on a scoring system where in general forested lands score positively and developed lands score negatively.



Shallow Waters Rating: Rating is based on a combination of the extent of estuarine and shallow marine areas associated with the watershed and stream.

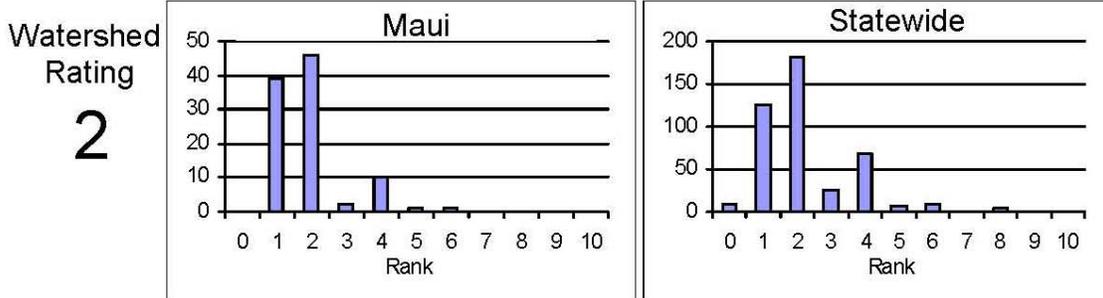


Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.

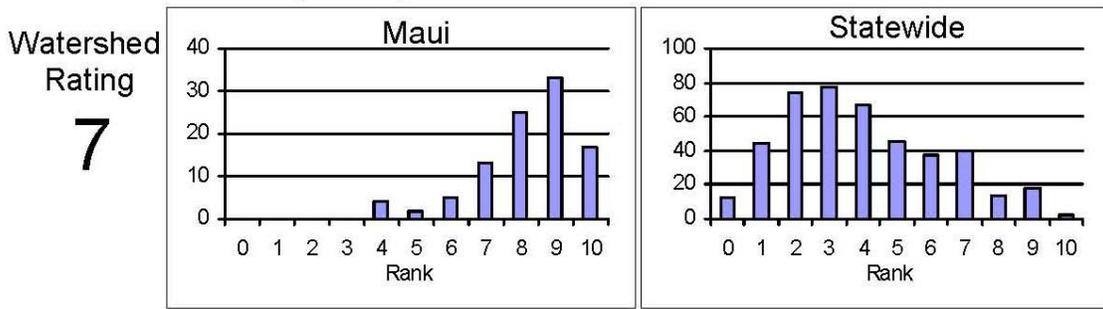


### WATERSHED RATING (Cont): Wailua Iki West, Maui

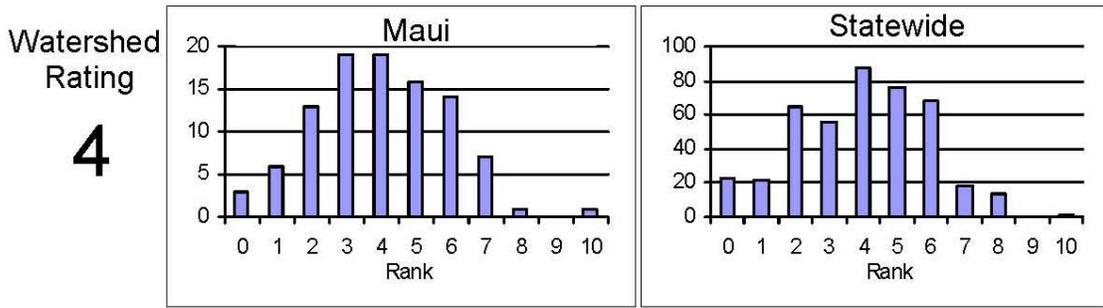
**Size Rating:** Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.



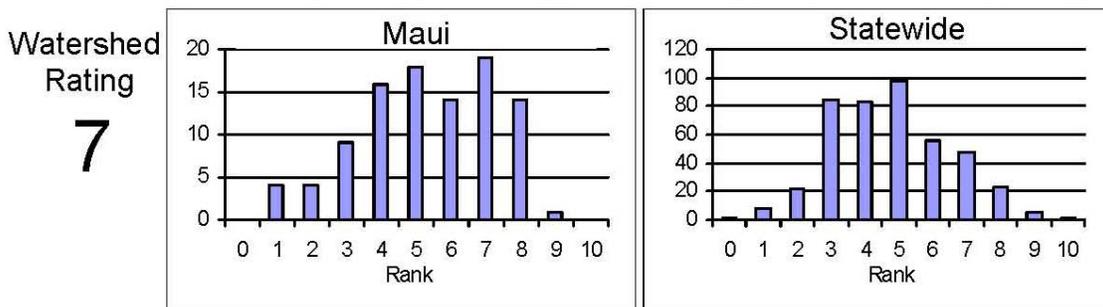
**Wetness Rating:** Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.



**Reach Diversity Rating:** Rating is based on the types and amounts of different stream reaches available in the watershed. More area in different reach types score more positively.



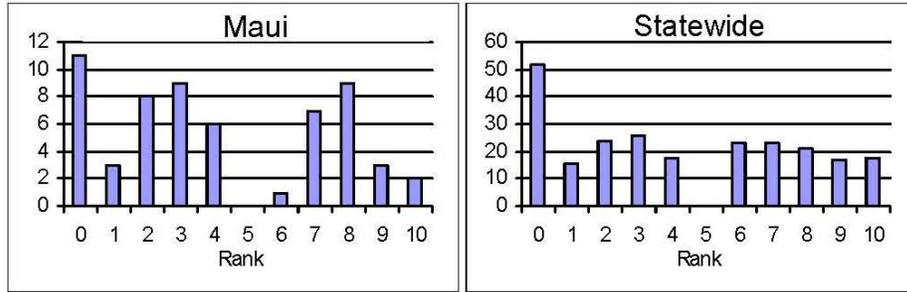
**Total Watershed Rating:** Rating is based on combination of Land Cover Rating, Shallow Waters Rating, Stewardship Rating, Size Rating, Wetness Rating, and Reach Diversity Rating.



**BIOLOGICAL RATING: Wailua Iki West, Maui**

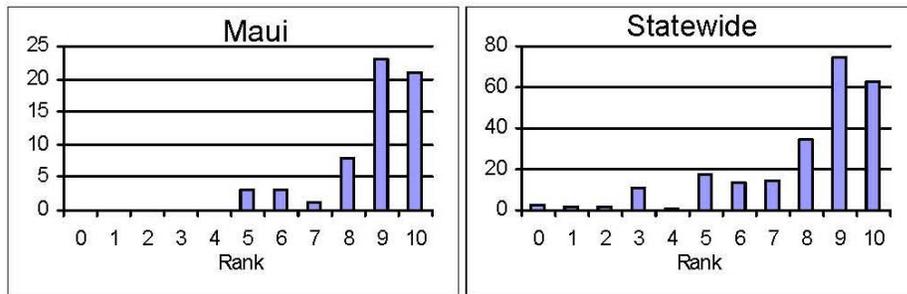
Native Species Rating: Rating is based on the number of native species observed in the watershed.

Stream Rating  
**8**



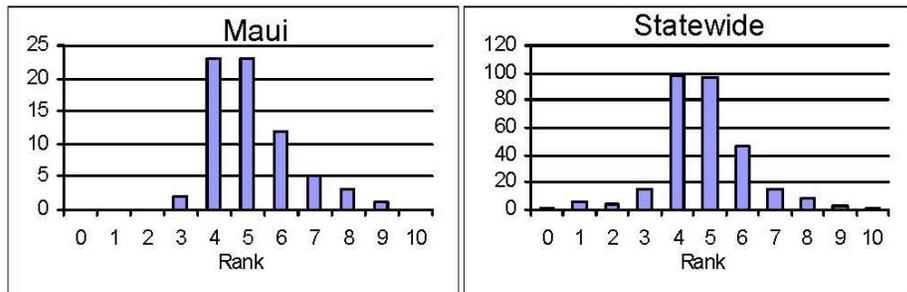
Introduced Genera Rating: Rating is based on the number of introduced genera observed in the watershed.

Stream Rating  
**8**



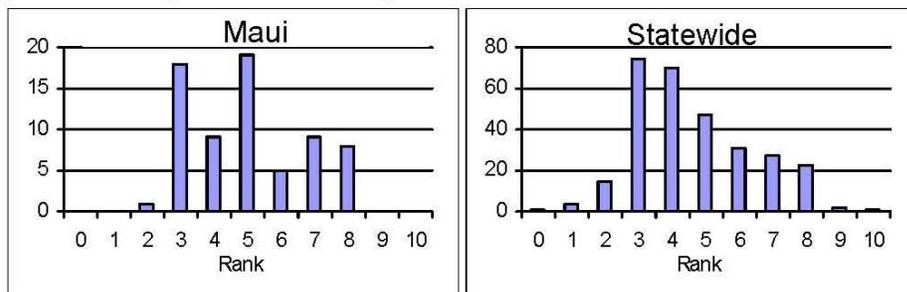
All Species' Score Rating: Rating is based on the Hawaii Stream Assessment scoring system where native species score positively and introduced species score negatively.

Stream Rating  
**7**



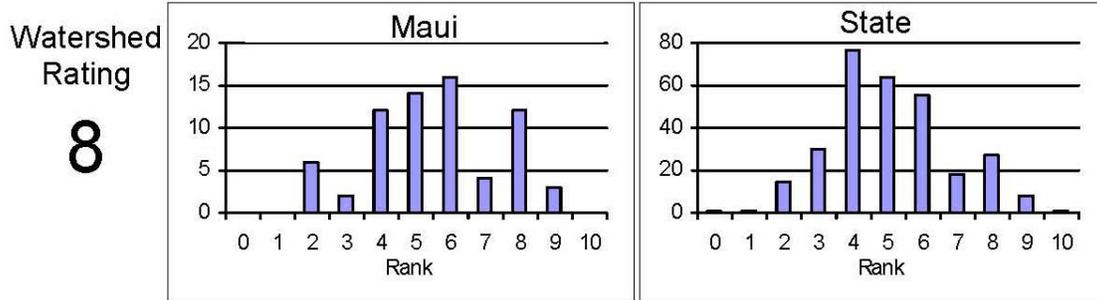
Total Biological Rating: Rating is the combination of the Native Species Rating, Introduced Genera Rating, and the All Species' Score Rating.

Stream Rating  
**7**



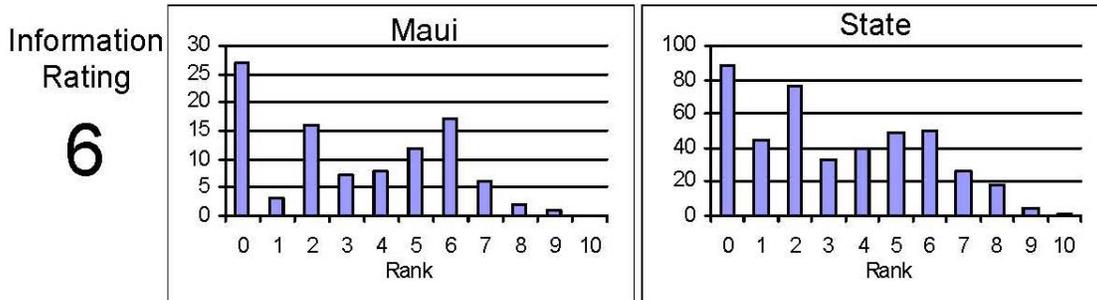
**OVERALL RATING: Wailua Iki West, Maui**

Overall Rating: Rating is a combination of the Total Watershed Rating and the Total Biological Rating.



**RATING STRENGTH: Wailua Iki West, Maui**

Rating Strength: Represents an estimate of the overall study effort in the stream and is a combination of the number of studies, number of different reaches surveyed, and the number of different survey types.



**REFERENCES**

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2003. Englund, R.A. et al. Systematic Inventory of Rare and Alien Aquatic Species in Selected O‘ahu, Maui, and Hawai‘i island Streams. Hawaii Biological Survey.

2005. Gingerich, S.B. and R.H. Wolff. Effects of Surface-Water Diversions on Habitat Availability for Native Macrofauna, Northeast Maui, Hawai‘i.

2006. Polhemus, D.A. Megalagrion Survey Notes in spreadsheet form.

2008. Hawai‘i Division of Aquatic Resources. DAR Point Quadrat Survey Data from the DAR Aquatic Surveys Database.

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## Section 3: DAR Point Quadrat Report for Wailua Iki West, Maui

For Surveys from 1/22/2003 to 5/12/2009

### Introduction

This is a report of the Hawaii Division of Aquatic Resources stream surveys using the Point Quadrat Methodology. Trained biologists and technicians survey a series of randomly located points in a stream to generate an assessment of the species and habitat in the stream. The Point Quadrat Methodology is one of several techniques that could be chosen for the surveys and is used to develop a statistically comparable stream survey. This methodology is a standardized visual survey technique involving snorkeling, and it is well suited for the physical and ecological characteristics of Hawai'i streams. The small, steep, dynamic nature of Hawaiian streams with their unique aquatic species is easily observed with this methodology. The in-stream distribution by elevation, behavior, and amphidromous life cycles are easily observed using this technique.

### Methods

The point quadrat methodology requires underwater observation. Sampling was conducted using a dive mask, snorkel and two-piece wet suit with hood and glove. Spiked felt-soled wading boots or Japanese spiked **tabis** are also necessary for easy climbing on the wet, algae-covered rocks. After the initial survey site is chosen all the survey sites upstream are selected randomly to prevent any bias in habitat type selection (e.g., pools and runs) and to obtain a representative sample of all habitat types in the stream. At each site, fish and invertebrate observations are recorded and data is collected on the species present, number, size, and sex. Habitat and substrate type, depth and site dimension data are also collected. Other site observations recorded at each station include GPS coordinates and the following water quality parameters using a Hydrolab Quanta: temperature (° C), salinity (PSS), dissolved oxygen (mg/L), pH, conductivity (mS/cm) and turbidity (NTU). Stream flow measurements are collected using a Marsh McBirney Flo-Mate 2000 at the beginning and ending of each survey as well as at tributaries and diversions.

The watersheds (and watershed ID), region, and island surveyed in this report are:

Wailua Iki West (ID: 64015), Ke'anae, Maui

Surveys were conducted by these personnel:

Hau, Skippy  
Higashi, Glenn  
Kuamo'o, Darrell  
Nishimoto, Robert  
Sakihara, Troy  
Shimoda, Troy  
Shindo, Tim

## Results

Table 3-1. The distribution of sites by reach during this survey effort.

Reach	Total number of surveys
<b>Estuary</b>	0
<b>Lower</b>	3
<b>Middle</b>	3
<b>Upper</b>	36
<b>Headwaters</b>	0
<b>Unknown</b>	0

### Lower Reach

Table 3-2. Number of Habitat Types surveyed in the lower stream reach.

Reach	Total Habitats Surveyed	Plunge Pool	Cascade	Riffle	Run	Pool	Side Pool	No Water	Dirty Water	Unknown
<b>Lower</b>	3	0	0	1	2	0	0	0	0	0

Table 3-3. Observed Substrates (%) in point quadrat samples in the lower stream reach.

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
<b>Lower</b>	9	0	4	11	15	35	26

Table 3-4. Observed Water Quality in point quadrat samples in the lower stream reach.

Reach	Temp (° C)	sCond (mS/cm)	DO (mg/L)	pH	Turbidity (NTU)
<b>Lower</b>	20.993	0.237	7.033	7.827	n/a

Table 3-5. Summary of species observed in the lower reach of the watershed.

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Crustacean	Introduced	<i>Macrobrachium lar</i>
Fish	Endemic	<i>Kuhlia xenura</i>
Snail	Endemic	<i>Neritina granosa</i>

Table 3-6. Average Density and Total number of animals observed in the lower stream reach. Density values are calculated only for random sites, not non-random or outside sites, greater than 6 by 6 inches. Density values are in number of animals per square yard.

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg. Density</u>	<u>Total # observed</u>
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Lower	1.3	1
Fish	Endemic	<i>Kuhlia xenura</i>	Lower	2.6	2
Snails	Endemic	<i>Neritina granosa</i>	Lower	6.51	5

### Middle Reach

Table 3-7. Observed Substrates (%) in point quadrat samples in the middle stream reach.

<b>Reach</b>	Total Habitats Surveyed	Plunge Pool	Cascade	Riffle	Run	Pool	Side Pool	No Water	Dirty Water	Unknown
<b>Middle</b>	2	1	0	0	1	0	0	0	0	0

Table 3-8. Observed Substrates (%) in point quadrat samples in the middle stream reach.

<b>Reach</b>	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
<b>Middle</b>	0	0	0	20	10	45	25

Table 3-9. Observed Water Quality in point quadrat samples in the middle stream reach.

<b>Reach</b>	Temp (° C)	sCond (mS/cm)	DO (mg/L)	pH	Turbidity (NTU)
<b>Middle</b>	22.08	0.085	7.237	7.893	n/a

Table 3-10. Summary of species observed in the middle reach of the watershed.

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Crustacean	Introduced	<i>Macrobrachium lar</i>
Fish	Endemic	<i>Sicyopterus stimpsoni</i>
Fish	Endemic	<i>Kuhlia xenura</i>
Fish	Endemic	<i>Eleotris sandwicensis</i>
Fish	Indigenous	<i>Awaous guamensis</i>
Snail	Endemic	<i>Neritina granosa</i>

Table 3-11. Average Density and Total number of animals observed in the middle stream reach. Density values are calculated only for random sites, not non-random or outside sites, greater than 6 by 6 inches. Density values are in number of animals per square yard.

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg. Density</u>	<u>Total # observed</u>
Fish	Endemic	<i>Sicyopterus stimpsoni</i>	Middle	1.15	2
Snails	Endemic	<i>Neritina granosa</i>	Middle	1.15	2

## Upper Reach

Table 3-12. Observed Substrates (%) in point quadrat samples in the upper stream reach.

<b>Reach</b>	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
<b>Upper</b>	1	1	6	22	13	30	27

Table 3-13. Observed Substrates (%) in point quadrat samples in the upper stream reach.

<b>Reach</b>	Total Habitats Surveyed	Plunge Pool	Cascade	Riffle	Run	Pool	Side Pool	No Water	Dirty Water	Unknown
<b>Upper</b>	36	6	0	1	17	7	5	0	0	0

Table 3-14. Observed Water Quality in point quadrat samples in the upper stream reach.

<b>Reach</b>	Temp (° C)	sCond (mS/cm)	DO (mg/L)	pH	Turbidity (NTU)
<b>Upper</b>	15.863	0.049	9.008	7.975	0.03

Table 3-15. Summary of species observed in the upper reach of the watershed.

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Amphibian	Introduced	Ranid sp.
Amphibian	Introduced	<i>Rana rugosa</i>
Crustacean	Endemic	<i>Atyoida bisulcata</i>
Insect	Indigenous	<i>Telmatogeton</i> sp.
Snail	Introduced	Physid sp.

Table 3-16. Average Density and Total number of animals observed in the upper stream reach. Density values are calculated only for random sites, not non-random or outside sites, greater than 6 by 6 inches. Density values are in number of animals per square yard.

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg. Density</u>	<u>Total # observed</u>
Amphibians	Introduced	Ranid sp.	Upper	0.15	2
Amphibians	Introduced	<i>Rana rugosa</i>	Upper	0.44	6
Crustaceans	Endemic	<i>Atyoida bisulcata</i>	Upper	13.97	190
Insects	Indigenous	<i>Telmatogeton</i> sp.	Upper	0.29	4
Snails	Introduced	Physid sp.	Upper	0.07	1

Table 3-17. Flow data taken during point quadrat in the lower stream reach.

Latitude	Longitude	Total CFS	MGD
20.83654	-156.12572	3.96	2.56

Table 3-18. Flow data taken during point quadrat in the middle stream reach.

Latitude	Longitude	Total CFS	MGD
20.83472	-156.12775	1.41	0.91

Table 3-19. Megalagrion species in observed in the upper stream reach.

Insect	Endemic	<i>Megalagrion calliphya</i>
Insect	Endemic	<i>Megalagrion hawaiiense</i>

## Summary

Surveys were conducted in Wailua Iki West Stream on 12 May 2009. A total of 337 m of stream length was surveyed in one discrete section. Water flow data was collected at 2 sites and no diversions were observed within the survey area.

Animal species observed in Wailua Iki West Stream during 12 May 2009 surveys:

### In the Lower Reach:

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Crustacean	Introduced	<i>Macrobrachium lar</i>
Fish	Endemic	<i>Kuhlia xenura</i>
Snail	Endemic	<i>Neritina granosa</i>

**In the Middle Reach:**

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Crustacean	Introduced	<i>Macrobrachium lar</i>
Fish	Endemic	<i>Sicyopterus stimpsoni</i>
Fish	Endemic	<i>Kuhlia xenura</i>
Fish	Endemic	<i>Eleotris sandwicensis</i>
Fish	Indigenous	<i>Awaous guamensis</i>
Snail	Endemic	<i>Neritina granosa</i>

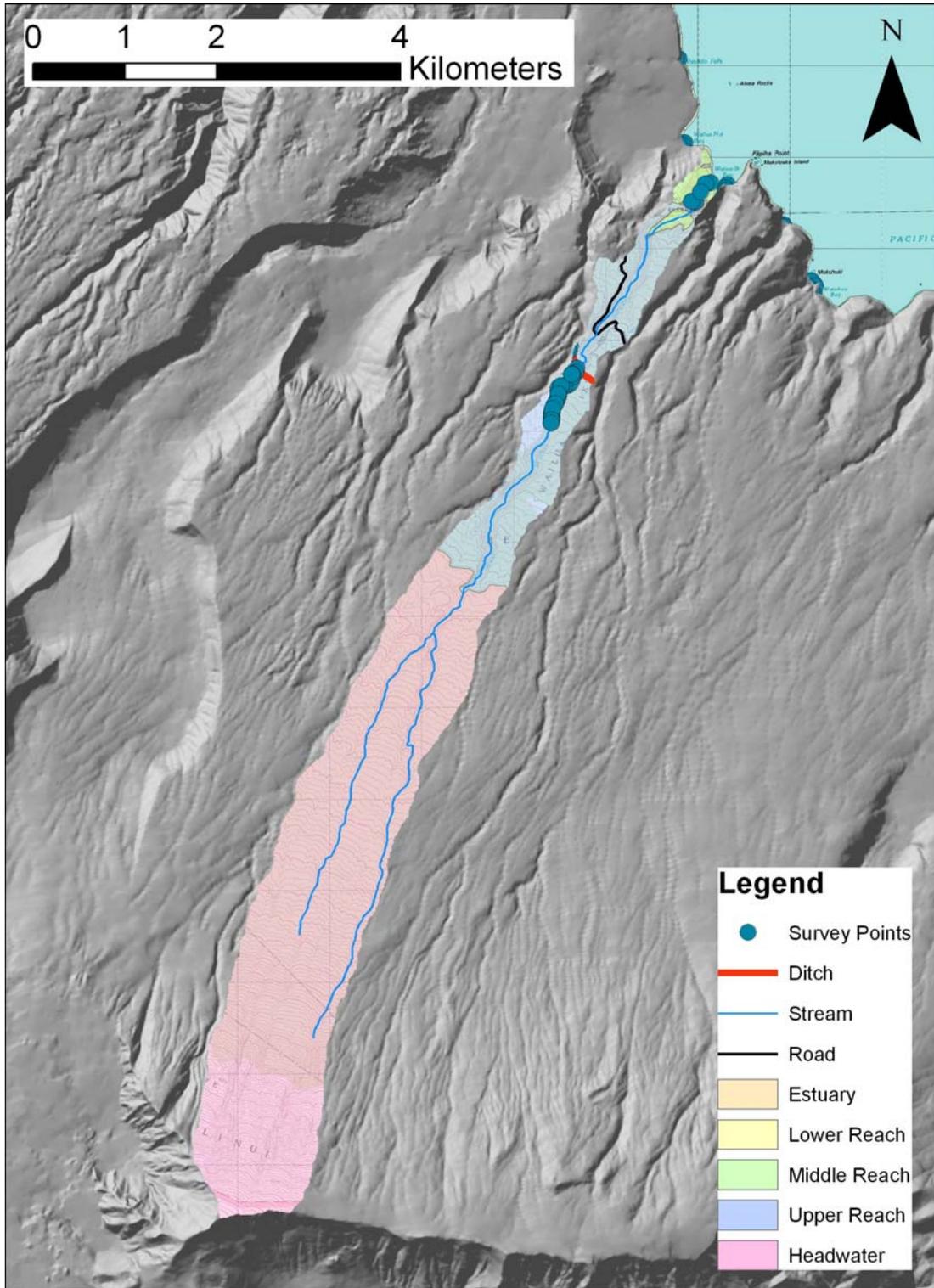


Figure 3-1. Location of point quadrat surveys conducted in Wailua Iki West Stream.

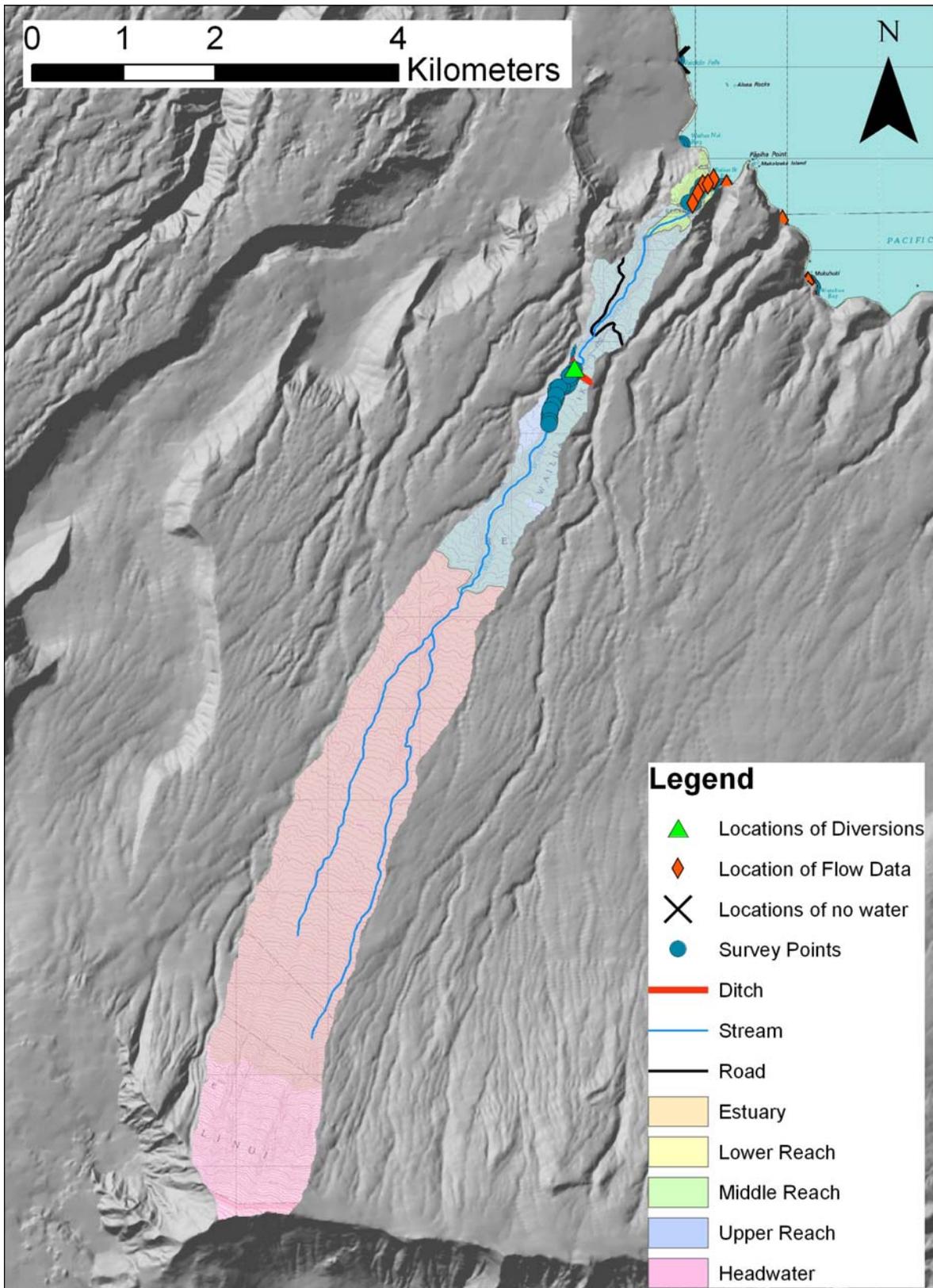


Figure 3-2. Location of diversion, no water and flow data surveys conducted in Wailua Iki West Stream.

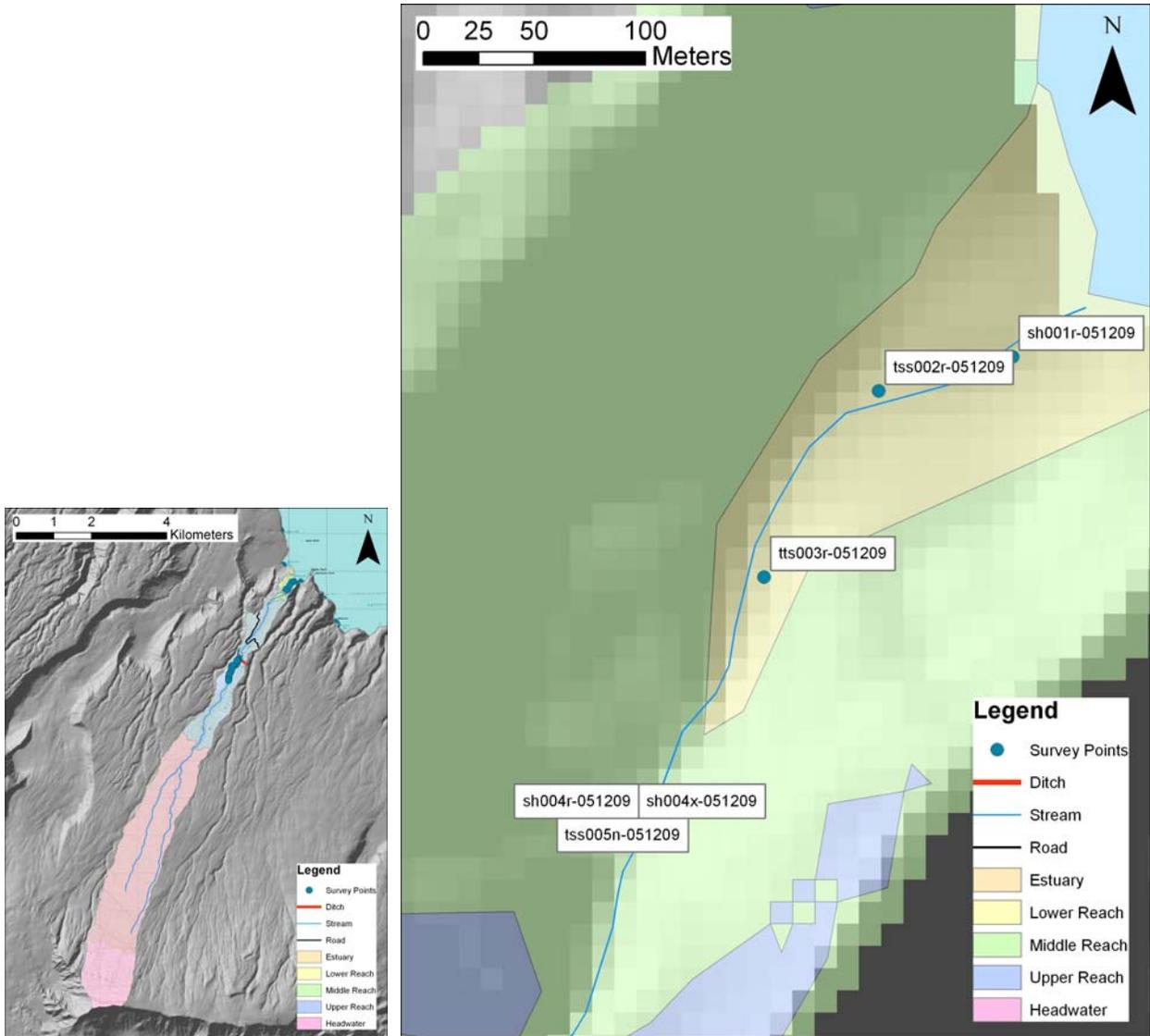


Figure 3-3. Point quadrat survey locations in the lower and middle reach of Wailua Iki West Stream.

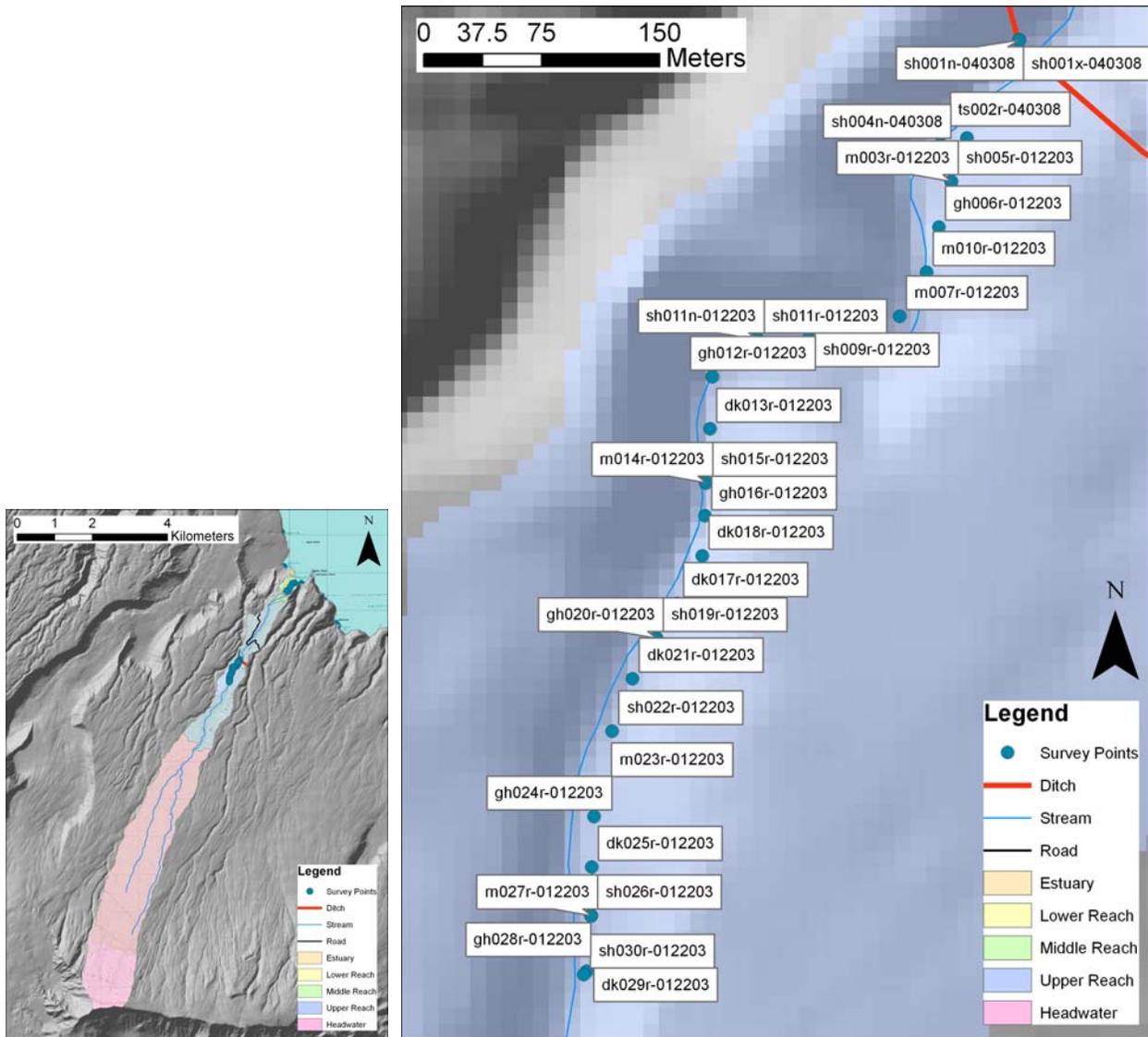


Figure 3-4. Point quadrat survey locations in the upper reach of Wailua Iki West Stream.

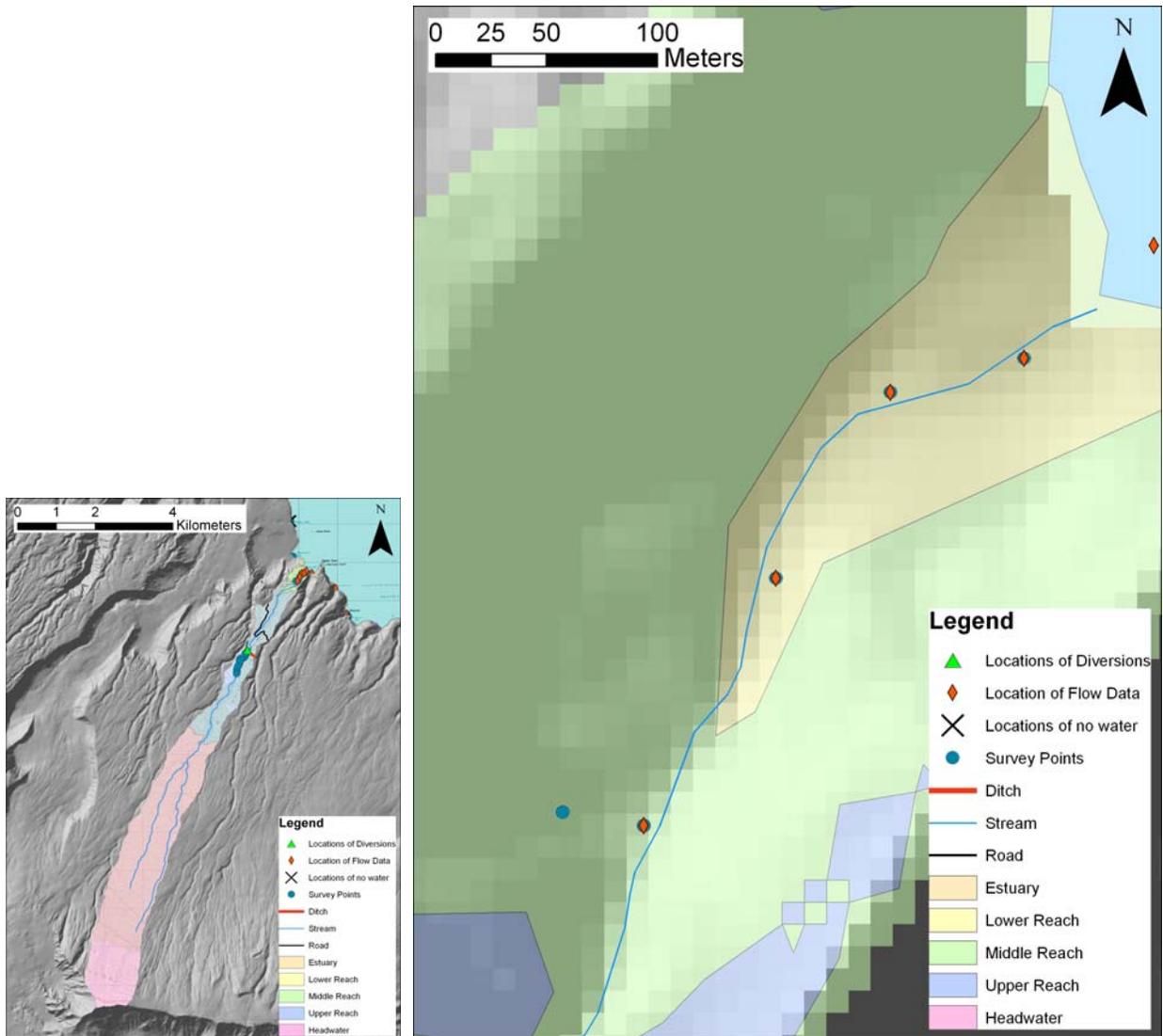


Figure 3-5. Flow survey locations in the lower and middle reach of Wailua Iki West Stream.

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## Section 4: DAR Estuary Survey Report for Wailua Iki West, Maui

For Surveys Conducted on: 5/12/2009

### Introduction

This is a report of the Hawaii Division of Aquatic Resources estuary survey conducted in Wailua Iki West Watershed, Maui. The main focus of the survey was to document physical conditions and animal species present in the estuary. Trained biologists and technicians sampled a series of randomly located points in the estuary to generate an assessment of species, habitat, and ecological connectivity to stream and coastal habitats. The estuary survey was conducted in conjunction with DAR point-quadrat stream surveys conducted in Wailua Iki West Stream to investigate the effect of stream conditions on the native biota in the stream and estuarine habitat of Wailua Iki West watershed. The data in this report reveals the potential adverse effects of stream alterations to biological resources in the stream and estuary, which bears significant ecological and cultural value. It also provides further information to determine instream flow standards and overall management of streams in Wailua Iki West watershed.

### Materials and Methods

Sampling was conducted using one cast net, 8 ft in length and ¼ in mesh size. Each random throw was considered a single survey site. The initial survey site was chosen non-randomly at the furthest extent of the estuary along the shoreline, which was determined by salinity level. Any salinity reading below 35‰ was considered estuarine conditions. The locations of random survey sites thereafter were determined by a random number system, which determined the approximate walking distance along the shoreline to the next survey site from the previous survey site. Fish and invertebrates captured in the net were separated, measured and recorded. All species captured were identified, measured and recorded in millimeters. Fish were measured by fork-length while invertebrates were measured by carapace length or total length depending on the classification of the specimen. All fish and invertebrates were measured manually with measuring boards. The following water quality parameters were measured and recorded at each station using a Hydrolab Quanta: temperature (° C), salinity (PSS), dissolved oxygen (mg/L), pH, conductivity (mS/cm) and turbidity (NTU). Other observations recorded were GPS coordinates, method of capture (i.e., random/non-random; cast net/scoop net), estuary status, estuary type, reach, habitat type, substrate composition (%), cloud cover (%), tide stage (ft) and depth (cm). All introduced species and mortally wounded specimens were kept, while all native species were released back into the estuary. Any unidentifiable specimens were kept and preserved in 5% formalin for later identification. Any unusual observations were also documented. This process was repeated along the shoreline until the extent of the estuary was surveyed, which was determined by a recorded salinity level equal to or greater than 35‰. Sampling also ceased if physical barriers that restricted continued surveying were reached (i.e., cliffs, hazardous terrain or high surf).

The Estuary Sampling Site, Wailua Iki West, is located in the region of Ke‘anae, Maui. The watershed (and watershed ID), region, and island surveyed in this report

Wailua Iki West (ID: 64015), Ke‘anae, Maui

Surveys were completed by these DAR staff:

- Hau, Skippy
- Sakihara, Troy
- Shindo, Timothy

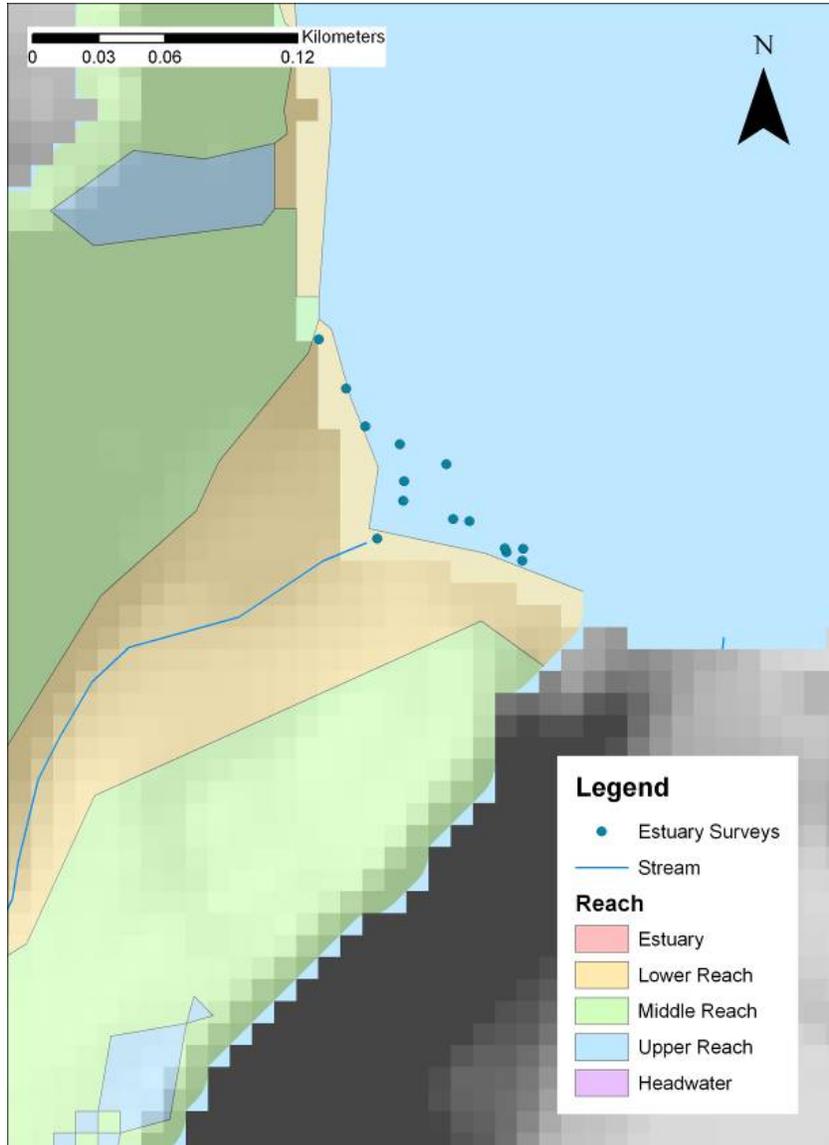


Figure 4-1. Location of estuary survey sites conducted in Wailua Iki West.

Results

Table 4-1. Summary of estuary classification and habitat description in Wailua Iki West, Maui.

<b>Location</b>	<b>Location ID</b>	<b>Estuary Status</b>	<b>Estuary Type</b>	<b>Reach</b>	<b>Habitat Type(s)</b>
Wailua Iki West	14	Natural	Coastal Embayment	Lower	Boulder

Table 4-2. Summary of the observed substrate average(s) (%) in the survey stations in Wailua Iki West.

<b>Avg Detritus</b>	<b>Avg Sediment</b>	<b>Avg Sand</b>	<b>Avg Gravel</b>	<b>Avg Cobble</b>
6	0	10	15	2
<b>Avg Boulder</b>	<b>Avg Bedrock</b>	<b>Avg Emergent Veg</b>	<b>Avg Submergent Veg</b>	<b>Avg Coral</b>
67	0	0	0	0

Table 4-3. Summary of the minimum, maximum, average, and the standard deviation of the depth observed in the survey sites in Wailua Iki West.

<b>Location</b>	<b>Location ID</b>	<b>Depth min (cm)</b>	<b>Depth max (cm)</b>	<b>Depth avg (cm)</b>	<b>Depth Std dev. (cm)</b>
Wailua Iki West	14	23	61	39	12.50

Table 4-4. Summary of the minimum, maximum, average, and the standard deviation of the dissolved oxygen observed in the survey stations in Wailua Iki West.

<b>Location</b>	<b>Location ID</b>	<b>DO min (mg/L)</b>	<b>DO max (mg/L)</b>	<b>DO avg. (mg/L)</b>	<b>DO Std. Dev. (mg/L)</b>
Wailua Iki West	14	5.05	7.28	5.73	0.73

Table 4-5. Summary of the minimum, maximum, average, and the standard deviation of the pH observed in the survey stations in Wailua Iki West.

Location	Location ID	pH min	pH max	pH avg.	pH Std. Dev.
Wailua Iki West	14	7.21	8.00	7.84	0.21

Table 4-6. Summary of the minimum, maximum, average, and the standard deviation of the salinity observed in the survey stations in Wailua Iki West.

Location	Location ID	Salinity min (ppt)	Salinity max (ppt)	Salinity avg. (ppt)	Salinity Std. Dev. (ppt)
Wailua Iki West	14	0.29	32.94	24.81	11.64

Table 4-7. Summary of the minimum, maximum, average, and the standard deviation of the temperature observed in the survey stations in Wailua Iki West.

Location	Location ID	Temp min (° C)	Temp max (° C)	Temp avg. (° C)	Temp Std. Dev. (° C)
Wailua Iki West	14	19.93	23.48	22.67	0.91

Table 4-8. Summary of species observed in survey sites.

Location	Location ID	Number of Surveys	Species	Category	Status	# of animals
Wailua Iki West	14	14	<i>Iso hawaiiensis</i>	Fish	Endemic	13
			<i>Kuhlia xenura</i>	Fish	Endemic	18
			<i>Neomyxus leuciscus</i>	Fish	Indigenous	1
			<i>Palaemon pacificus</i>	Crustacean	Indigenous	2

Table 4-9. Summary of size. Fish in fork length and crustaceans in total length.

Species	Category	# of animals	Max(mm)	Min(mm)	Avg(mm)	Std. Dev.
<i>Iso hawaiiensis</i>	Fish	13	31	23	28	2.80
<i>Kuhlia xenura</i>	Fish	18	84	35	62	14.87
<i>Neomyxus leuciscus</i>	Fish	1	75	75	75	
<i>Palaemon pacificus</i>	Crustacean	2	18	18	18	

### Summary

Estuary Surveys were conducted in the estuary reach of Wailua Iki West. A total of 165m of shoreline was surveyed in 1 discrete section. The physical characteristics of Wailua Iki West estuary matched that of Wailua Iki East, for both east and west streams entered the same embayment. The mouth of Wailua Iki West was open with some flowing water. Water conditions were relatively calm, but no detritus was observed as it was in the eastern section of the embayment. All species recorded were commonly captured in estuary samples conducted in East Maui.

Species observed in Wailua Iki West Estuary:

#### Native Species

Fish                    *Iso hawaiiensis*, Hawaiian Surf fish  
                               *Kuhlia xenura*, Āholehole  
                               *Neomyxus leuciscus*, Uouoa

Crustacean            *Palaemon pacificus*, Tiger shrimp

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## Section 5: Photographs taken during stream surveys

### Estuary

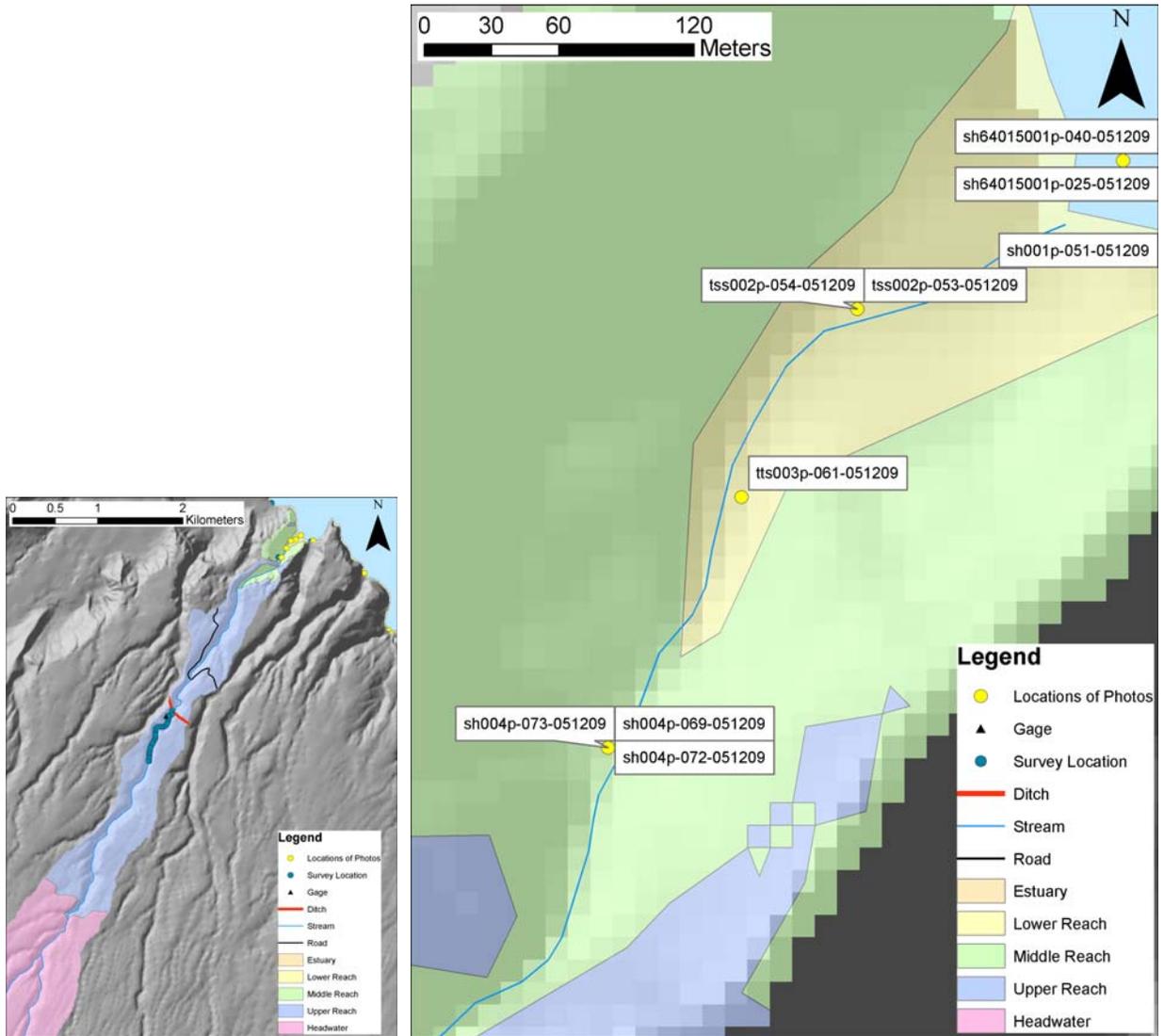


Figure 5-1. Photo locations in the estuary and lower reach of Wailua Iki West.



Figure 5-2. Aerial photo of Wailua Iki West entering ocean in center and Wailua Iki East entering on left side of photo. (4/8/2009; Tributary name: Wailua Iki West (64015001); PBN: dk64015001p-009-040809; Surveyor: Kuamo‘o, D.



Figure 5-3. Wailua Iki West Stream mouth entering ocean. (4/8/2009; Tributary name: Wailua Iki West (64015001); PBN: dk64015001p-012-040809); Photo by: Kuamo‘o, D.



Figure 5-4. Photo of the mouth of Wailua Iki West Stream. Photo taken during high tide in afternoon. (5/12/2009; Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-100-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-5. View of estuary in Wailua Iki West. Photo oriented westward looking towards mouth of Wailua Iki West Stream taken at low tide in the morning. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-001-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-6. DAR surveyors collecting samples in Wailua Iki West estuary during high tide. Photo oriented northward. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-021-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-7. View of Wailua Iki West estuary from the mouth of Wailua Iki West Stream. Photo oriented eastward looking towards Wailua Iki East Stream. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-023-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-8. DAR surveyors collecting fish samples with a cast net at the mouth of Wailua Iki West Stream at low tide in the morning. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-025-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-9. An abundance of limpets (*Cellana exarata* and *Cellana sandwicensis*) along boulder shoreline of Wailua Iki West watershed at low tide. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-040-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-10. Mouth of Wailua Iki West Stream. Image is oriented upstream at high tide. The mouth of the stream was open. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-099-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).



Figure 5-11. Hawaiian surf fish (*Iso hawaiiensis*) recorded in Wailua Iki West estuary at site 13. (5/12/2009, Tributary name: Wailua Iki West (64015001), PBN: sh64015001p-095-051209, Lat. (DD): 20.83699, Long. (DD): -156.12515).

Lower Reach



Figure 5-12. Survey site 1. View of stream mouth of Wailua Iki West Stream. Photo oriented downstream from site 1. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: sh001p-051-051209; Surveyor: Hau, S.; Habitat type: Run; SBN: sh001r-051209; Lat. (DD): 20.83654, Long. (DD): -156.12572).

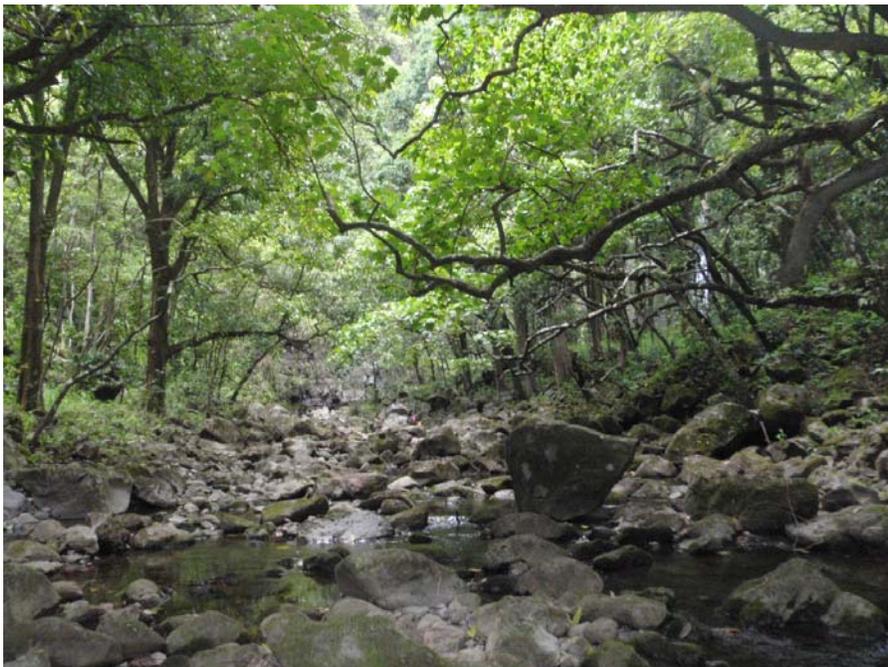


Figure 5-13. Photo shows the view upstream of survey site 2. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: tss002p-053-051209; Surveyor: Sakihara, T.; Habitat type:

Riffle; SBN: tss002r-051209; Lat. (DD): 20.83641, Long. (DD): -156.1263).



Figure 5-14. Survey site 2. Image shows downstream of survey site 2. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: tss002p-054-051209; Surveyor: Sakihara, T.; Habitat type: Riffle; SBN: tss002r-051209; Lat. (DD): 20.83641, Long. (DD): -156.12630).



Figure 5-15. Survey site 3. Image shows the surrounding area of the survey site. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: tts003p-061-051209; Surveyor: Shindo, T.; Habitat type: Run; SBN: tts003r-051209; Lat. (DD): 20.83566, Long. (DD): -156.12681).



Figure 5-16. View of streambed from site 4 in Wailua Iki West Stream. Photo taken downstream. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: sh004p-069-051209; Surveyor: Hau, S.; Habitat type: Run; SBN: sh004r-051209; Lat. (DD): 20.83466, Long. (DD): -156.1274).



Figure 5-17. DAR surveyors in front of waterfall and plunge pool at site 5. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: sh004p-072-051209; Surveyor: Hau, S.; Habitat type: Run; SBN: sh004r-051209; Lat. (DD): 20.83466, Long. (DD): -156.1274).



Figure 5-18. Survey site 4. Two adult Hihīwai (*Neritina granosa*), which were observed in abundance in Wailua Iki West lower and middle reach. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: sh004p-073-051209; Surveyor: Hau, S.; Habitat type: Run; SBN: sh004r-051209; Lat. (DD): 20.83466, Long. (DD): -156.1274).



Figure 5-19. Survey site 4. Algal grazing patch created by adult *Sicyopterus stimpsoni*, found in abundance in the lower and middle reaches of Wailua Iki West Stream. (5/12/2009; Tributary name: Wailua Iki West (64015001); PBN: sh004p-083-051209; Surveyor: Hau, S.; Habitat type: Run; SBN: sh004r-051209; Lat. (DD): 20.83466, Long. (DD): -156.1274).

Upper Reach



Figure 5-20. (CWRM diversion photo 327.1)



Figure 5-21. (CWRM Diversion photo 327.3)



Figure 5-22. (CWRM Diversion photo 327.5)



Figure 5-23. (CWRM Diversion photo K16E)



Figure 5-24. (CWRM Diversion photo K16G.1)



Figure 5-25. (CWRM Diversion photo K17A.1)



Figure 5-26. (CWRM Diversion photo K17A.3)



Figure 5-27. Reach above ditch road on Wailua Iki West. (4/8/2009; Tributary name: (64015001); PBN: dk64015001p-014-040809; Photo by: Kuamo'o, D.

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## Appendix: Survey Sites Latitude and Longitude

<u>Tributary</u>	<u>Stream</u>	<u>Survey Book #</u>	<u>Site</u>	<u>Surveyor</u>	<u>Date</u>	<u>Latitude</u>	<u>Longitude</u>
64015001	Wailua Iki West	sh001n-012203	1	Hau, Skippy	1/22/2003	20.81806	-156.14019
64015001	Wailua Iki West	sh002r-012203	2	Hau, Skippy	1/22/2003	20.81806	-156.14019
64015001	Wailua Iki West	rn003r-012203	3	Nishimoto, Robert	1/22/2003	20.81766	-156.14051
64015001	Wailua Iki West	dk004r-012203	4	Kuamo'o, Darrell	1/22/2003	20.81791	-156.14041
64015001	Wailua Iki West	sh005r-012203	5	Hau, Skippy	1/22/2003	20.81766	-156.14051
64015001	Wailua Iki West	gh006r-012203	6	Higashi, Glenn	1/22/2003	20.81740	-156.14059
64015001	Wailua Iki West	rn007r-012203	7	Nishimoto, Robert	1/22/2003	20.81689	-156.14084
64015001	Wailua Iki West	dk008r-012203	8	Kuamo'o, Darrell	1/22/2003	20.81677	-156.14109
64015001	Wailua Iki West	sh009r-012203	9	Hau, Skippy	1/22/2003	20.81677	-156.14140
64015001	Wailua Iki West	rn010r-012203	10	Nishimoto, Robert	1/22/2003	20.81714	-156.14067
64015001	Wailua Iki West	sh011r-012203	11	Hau, Skippy	1/22/2003	20.81677	-156.14171
64015001	Wailua Iki West	sh011n-012203	11	Hau, Skippy	1/22/2003	20.81677	-156.14171
64015001	Wailua Iki West	gh012r-012203	12	Higashi, Glenn	1/22/2003	20.81656	-156.14199
64015001	Wailua Iki West	dk013r-012203	13	Kuamo'o, Darrell	1/22/2003	20.81626	-156.14201
64015001	Wailua Iki West	rn014r-012203	14	Nishimoto, Robert	1/22/2003	20.81595	-156.14204
64015001	Wailua Iki West	sh015r-012203	15	Hau, Skippy	1/22/2003	20.81595	-156.14204
64015001	Wailua Iki West	gh016r-012203	16	Higashi, Glenn	1/22/2003	20.81576	-156.14205
64015001	Wailua Iki West	dk017r-012203	17	Kuamo'o, Darrell	1/22/2003	20.81526	-156.14223
64015001	Wailua Iki West	dk018r-012203	18	Kuamo'o, Darrell	1/22/2003	20.81553	-156.14207
64015001	Wailua Iki West	sh019r-012203	19	Hau, Skippy	1/22/2003	20.81506	-156.14236
64015001	Wailua Iki West	gh020r-012203	20	Higashi, Glenn	1/22/2003	20.81506	-156.14236
64015001	Wailua Iki West	dk021r-012203	21	Kuamo'o, Darrell	1/22/2003	20.81483	-156.14251
64015001	Wailua Iki West	sh022r-012203	22	Hau, Skippy	1/22/2003	20.81453	-156.14264
64015001	Wailua Iki West	rn023r-012203	23	Nishimoto, Robert	1/22/2003	20.81423	-156.14269
64015001	Wailua Iki West	gh024r-012203	24	Higashi, Glenn	1/22/2003	20.81404	-156.14276
64015001	Wailua Iki West	dk025r-012203	25	Kuamo'o, Darrell	1/22/2003	20.81375	-156.14278
64015001	Wailua Iki West	sh026r-012203	26	Hau, Skippy	1/22/2003	20.81347	-156.14279
64015001	Wailua Iki West	rn027r-012203	27	Nishimoto, Robert	1/22/2003	20.81347	-156.14279
64015001	Wailua Iki West	gh028r-012203	28	Higashi, Glenn	1/22/2003	20.81347	-156.14279
64015001	Wailua Iki West	dk029r-012203	29	Kuamo'o, Darrell	1/22/2003	20.81315	-156.14282
64015001	Wailua Iki West	sh030r-012203	30	Hau, Skippy	1/22/2003	20.81313	-156.14284
64015001	Wailua Iki West	sh001x-040308		Hau, Skippy	4/3/2008	20.81847	-156.14008
64015001	Wailua Iki West	sh001n-040308	1	Hau, Skippy	4/3/2008	20.81847	-156.14008
64015001	Wailua Iki West	ts002r-040308	2	Shimoda, Troy	4/3/2008	20.81794	-156.14055
64015001	Wailua Iki West	tts003n-040308	3	Shindo, Tim	4/3/2008	20.81787	-156.14058
64015001	Wailua Iki West	sh004n-040308	4	Hau, Skippy	4/3/2008	20.81787	-156.14058
64015001	Wailua Iki West	sh004x-051209		Hau, Skippy	5/12/2009	20.83466	-156.12740

**Appendix: Survey Sites Latitude and Longitude (continued)**

<b>Tributary</b>	<b>Stream</b>	<b>Survey Book #</b>	<b>Site</b>	<b>Surveyor</b>	<b>Date</b>	<b>Latitude</b>	<b>Longitude</b>
64015001	Wailua Iki West	sh001r-051209	1	Hau, Skippy	5/12/2009	20.83654	-156.12572
64015001	Wailua Iki West	tss002r-051209	2	Sakihara, Troy	5/12/2009	20.83641	-156.12630
64015001	Wailua Iki West	tts003r-051209	3	Shindo, Tim	5/12/2009	20.83566	-156.12681
64015001	Wailua Iki West	sh004r-051209	4	Hau, Skippy	5/12/2009	20.83466	-156.12740
64015001	Wailua Iki West	tss005n-051209	5	Sakihara, Troy	5/12/2009	20.83472	-156.12775

