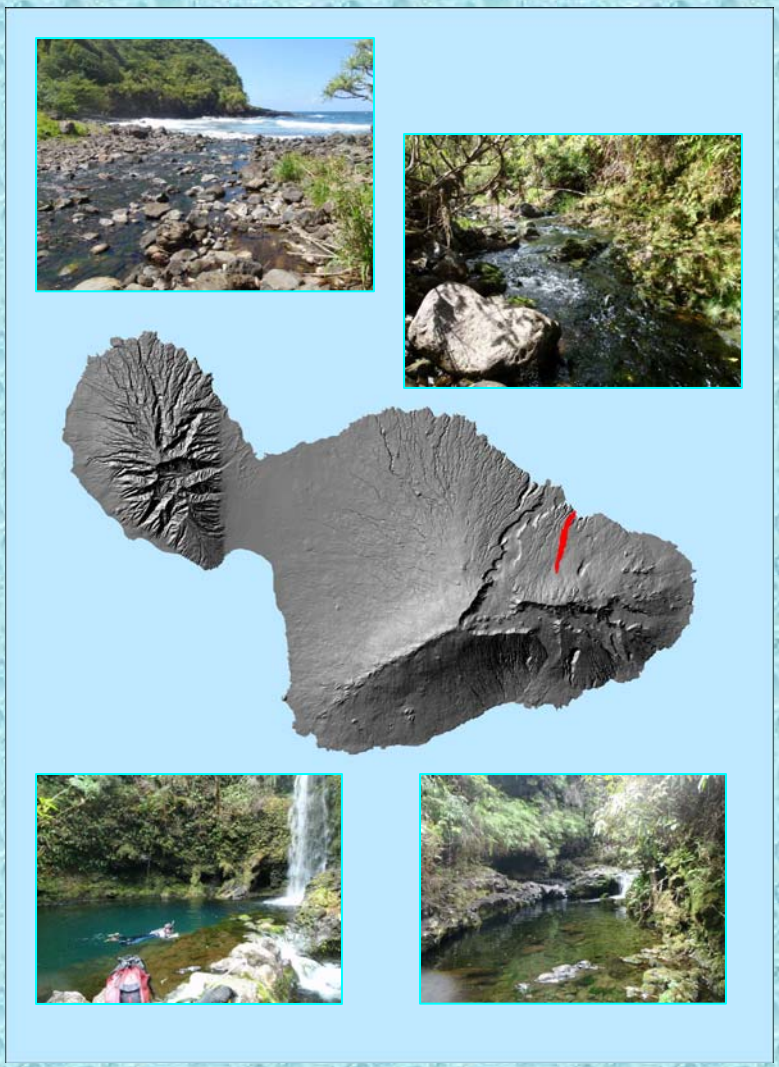
Report on Waiohue Stream
Maui, Hawaii



August 2009

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

Funded in part by the Commission on Water Resource Management, DLNR
and

Funded in part by the U.S. Fish & Wildlife Service through its State Wildlife Grant and Wildlife and Sport Fish Restoration Program.

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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[1]
Department of Land and Natural Resources
State of Hawai‘i
and
Bishop Musuem[2]

Authors:
Glenn Higashi[1], James Parham[2], Eko Lapp[1], Skippy Hau[1], Darrell Kuamo‘o[1], Lance Nishiura[1], Tim Shindo[1], Troy Sakihara[1], Troy Shimoda[1], and Robert Nishimoto[1] and Dan Polhemus[1]

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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 Waiohue Stream, Maui from year 2000 to present. The focus of this report is on the animals 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 Waiohue Stream while also providing substantial evidence to support the conclusions presented.

Findings for Waiohue Stream, Maui

Waiohue is a small (1.4 sq miles). It is mostly zoned for conservation (99%) with a little agriculture (1%). The land cover is mostly evergreen forest (90%), scrub (7%) and grassland (3%). Numerous stream surveys of different types have been completed in Waiohue stream beginning in 1962 to the present. This watershed rates high in comparison to other watersheds in Maui and statewide, based on data in the DAR aquatic surveys database. It has a total watershed rating of 7 out of 10, a total biological rating of 8 out of 10, and a combined overall rating of 7 out of 10.

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

Fish - *Awaous guamensis, Eleotris sandwicensis, Kuhlia sandvicensis, Kuhlia* sp., *Kuhlia xenura, Lentipes concolor, Mugil cephalus, Sicyopterus stimpsoni* and *Stenogobius hawaiiensis*

Crustaceans - *Amphipoda* sp*., Atyoida bisulcata* and *Macrobrachium grandimanus*

Insect – *Anax junius* , *Megalagrion* sp. and *Telmatogen* sp.

Snails – *Ferrissia sharpi* , *Nerita picea, Neritina granosa,* Neritid sp. and *Neritina vespertina*

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

Amphibian – *Rana rugosa*

Fish – *Poecilia reticulata*

Crustaceans - Isopod sp. and *Macrobrachium lar*

Insects - *Cheumatopsyche analis,* Chironomid sp. and *Enallagma civile*

Discussion

Waiohue watershed is small, narrow and steep with a small embayment at the stream mouth. The stream mouth consists of a cobble and boulder beach and rises quickly in elevation moving inland from the stream mouth.

A helicopter was used to access the lower and upper reaches of Waiohue Stream during the surveys of the estuary and other reaches because of the steep watersheds and inaccessibility by foot. The middle section and stream diversion were accessed from Hāna highway.

The physical characteristics of Waiohue estuary consisted of boulder terrain, white water and high surge in a small coastal embayment, typical of East Maui. The mouth of Waiohue Stream had minimal flow entering the ocean which may be due to the effects of diversions upstream.

The estuary was sampled twice, once in the morning at low tide and in the afternoon at high tide. Cast net sampling resulted in the collection of two species, **Kūpīpī** (*Abudefduf sordidus*) and **āholehole** (*Kuhlia xenura*). The **āholehole** (N=130) caught ranged in size from 2 to 5 inches in length and were captured in the stream mouth and various sites along the shore and at varying salinities. **‘Opihi** (*Cellana sandwicensis* and *Cellana exarata*) were present along the shoreline. **Hapawai** (*Neritina vespertina*) were not observed in the estuary.

Point quadrat surveys were conducted in Waiohue Stream from the mouth to the upper reach. **ʻOʻopu nōpili** (*Sicyopterus stimpsoni*) and *K. xenura* were observed near the stream mouth in a riffle habitat with gravel, cobble, and boulder substrate with water temperature of 20.5º C. In the lower section from the stream mouth up to the middle reach below the highway, the stream sites were characterized by run habitats with boulder, cobble, and gravel substrate with water temperatures of 20.4º C. Stream flow in this section was 2.5 cfs. In the upper reach near Hāna Highway and the diversion, the stream was typically composed of plunge pool habitat with boulder, gravel, and cobble substrates with water temperature of 20.4º C. Species observed included *S. stimpsoni,* **ʻoʻopu nākea** (*Awaous guamensis*), and **hīhīwai** (*Neritina granosa*). Water was barely flowing below the Hāna Highway Bridge (Figure 5-14.) and a flow measurement of 0.22 cfs was taken above the highway. The stream diversion removes the majority of the low flow at the highway bridge. In the upper reach above the diversion, the stream had substantial flow with a measurement of 7.66 cfs and was characterized by pool, plunge pool, riffle, and run habitats with bedrock boulder, and cobble substrates. The water temperature was 17.7º C. The only native species observed in this upper section was **ʻōpae kalaʻole** (*Atyoida bisulcata*) (N=51) with an average density value of 8.1 animals per square yard.

Lower Waiohue Stream had a number of native amphidromous animals, with an abundance of *A. bisulcata* in the upper stream section. Flow restoration could improve the downstream habitat and provide better connection between upstream habitats with the ocean. Water restoration may also benefit the stream mouth and estuarine communities, although not a lot of habitat exists here in the best of conditions.

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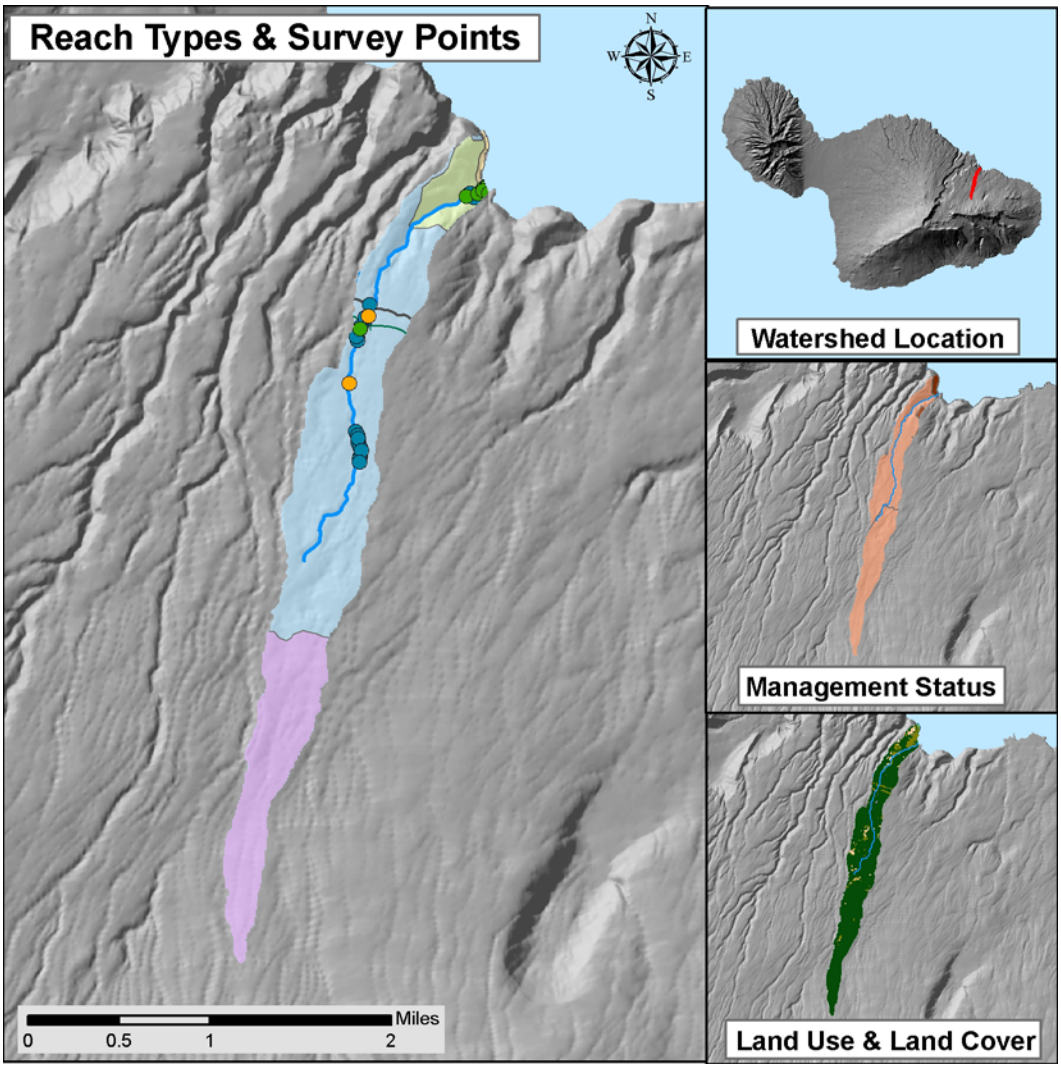
Section 2: Watershed Atlas

DAR Watershed Code: 64018

Waiohue, Maui



WATERSHED FEATURES

Waiohue watershed occurs on the island of Maui. The Hawaiian meaning of the name is unknown. The area of the watershed is 1.4 square mi (3.5 square km), with maximum elevation of 4003 ft (1220 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: 1% agricultural, 99% 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.

Military	Federal	State	OHA	County	Nature Conservancy	Other Private
0.0	0.0	97.1	0.0	0.0	0.0	2.9

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

Permanent Biodiversity Protection	Managed for Multiple Uses	Protected but Unmanaged	Unprotected
0.0	97.1	0.0	2.9

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

	Percent	Square mi	Square km
High Intensity Developed	0.0	0.00	0.00
Low Intensity Developed	0.2	0.00	0.01
Cultivated	0.0	0.00	0.00
Grassland	2.6	0.04	0.09
Scrub/Shrub	6.6	0.09	0.23
Evergreen Forest	90.4	1.23	3.20
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	0.1	0.00	0.00
Unconsolidated Shoreline	0.1	0.00	0.00
Water	0.1	0.00	0.00
Unclassified	0.0	0.00	0.00

STREAM FEATURES

Waiohue is a perennial stream. Total stream length is 2.6 mi (4.3 km). The terminal stream order is 1.

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

Estuary	Lower	Middle	Upper	Headwaters
0.6	3.6	15.4	80.4	0.0

The following stream(s) occur in the watershed:
Waiohue

BIOTIC SAMPLING EFFORT

Biotic samples were gathered in the following year(s):
1962 1975 1979 1980 2003 2009

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

Survey type	Estuary	Lower	Middle	Upper	Headwaters
DAR Point Quadrat	2	3	1	17	0
HDFG	0	0	0	2	0
Published Report	1	3	1	1	0

BIOTA INFORMATION

Species List

Native Species

Crustaceans	Amphipod sp.
	Atyoida bisulcata
	Macrobrachium grandimanus
Fish	*Awaous guamensis*
	Eleotris sandwicensis
	Kuhlia sandvicensis
	Kuhlia sp.
	Kuhlia xenura
	Lentipes concolor
	Mugil cephalus
	Sicyopterus stimpsoni
	Stenogobius hawaiiensis
Snails	*Ferrissia sharpi*
	Nerita picea
	Neritid sp.
	Neritina granosa
	Neritina vespertina

Native Species

Insects	*Anax junius*
	Megalagrion sp.
	Telmatogeton sp.

Introduced Species

Crustaceans	Isopod sp.
	Macrobrachium lar
Fish	*Poecilia reticulata*

Introduced Species

Insects	*Cheumatopsyche analis*
	Chironomid sp.
	Enallagma civile

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

Scientific Name	Status	Minimum Size	Maximum Size	Average Size
Atyoida bisulcata	Endemic	0.75	2	1.5
Macrobrachium lar	Introduced	2.5	6	3.8
Kuhlia xenura	Endemic	1.5	1.5	1.5
Sicyopterus stimpsoni	Endemic	1.25	2.25	1.8
Awaous guamensis	Indigenous	1.5	5	3.1
Neritina granosa	Endemic	0.125	1	0.2

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

Scientific Name	Status	Estuary	Lower	Middle	Upper	Headwaters
Atyoida bisulcata	Endemic				10.1	
Neritina granosa	Endemic		182.	190.		
Sicyopterus stimpsoni	Endemic			2.57		
Awaous guamensis	Indigenous		5.26	2.57		
Macrobrachium lar	Introduced		1.05	12.8		

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

Scientific Name	Status	Estuary	Lower	Middle	Upper	Headwaters
Atyoida bisulcata	Endemic	P	P	P	P	
Macrobrachium grandimanus	Endemic	P	P			
Eleotris sandwicensis	Endemic	P	P			
Kuhlia xenura	Endemic	P				
Sicyopterus stimpsoni	Endemic	P	P	P		
Stenogobius hawaiiensis	Endemic	P	P			
Megalagrion sp.	Endemic		P		P	
Ferrissia sharpi	Endemic		P	P		
Neritina granosa	Endemic	P	P	P		
Neritina vespertina	Endemic	P				
Amphipod sp.	Indigenous	P	P			
Awaous guamensis	Indigenous	P	P	P		
Kuhlia sandvicensis	Indigenous	P	P			
Kuhlia sp.	Indigenous		P			
Mugil cephalus	Indigenous	P				
Anax junius	Indigenous		P			
Telmatogeton sp.	Indigenous		P	P	P	
Nerita picea	Indigenous	P				
Neritid sp.	Indigenous	P				
Isopod sp.	Introduced	P				
Macrobrachium lar	Introduced	P	P	P		
Cheumatopsyche analis	Introduced		P			
Chironomid sp.	Introduced				P	
Enallagma civile	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): Outstanding

U.S. Fish and Wildlife Service High Quality Stream (1988): Yes

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 > 19 spp.	Native Macrofauna Diversity > 5 spp.	Absence of Priority 1 Introduced
No	Yes	No
Abundance of Any Native Species	**Presence of Candidate Endangered Species**	**Endangered Newcomb's Snail Habitat**
No	No	No

CURRENT WATERSHED AND STREAM RATINGS

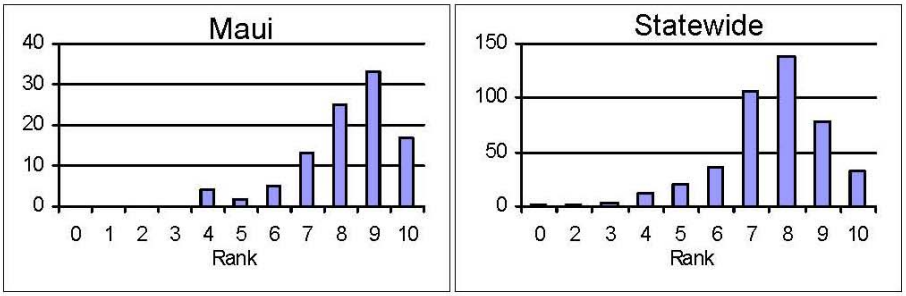
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding 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: Waiohue, Maui

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

Watershed Rating

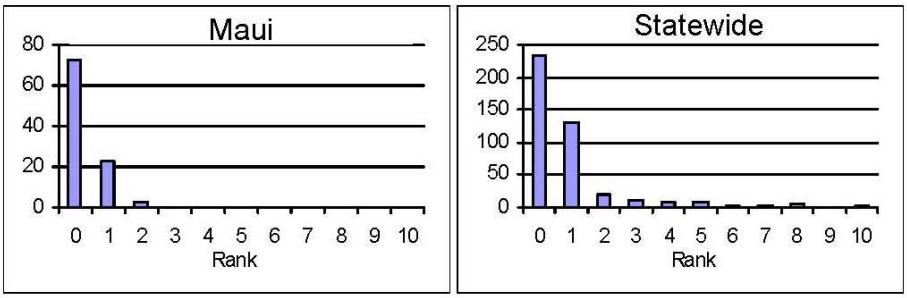
10



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

Watershed Rating

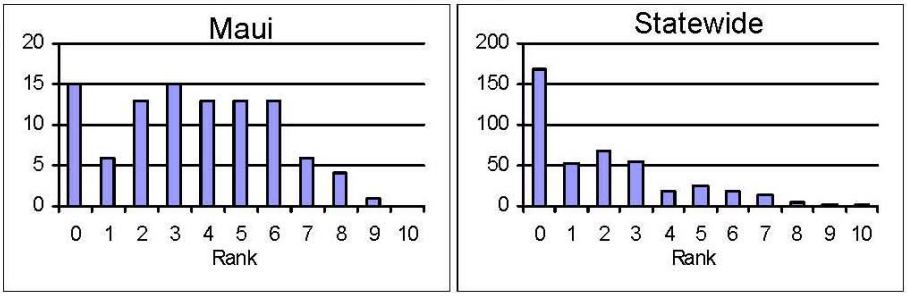
0



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

Watershed Rating

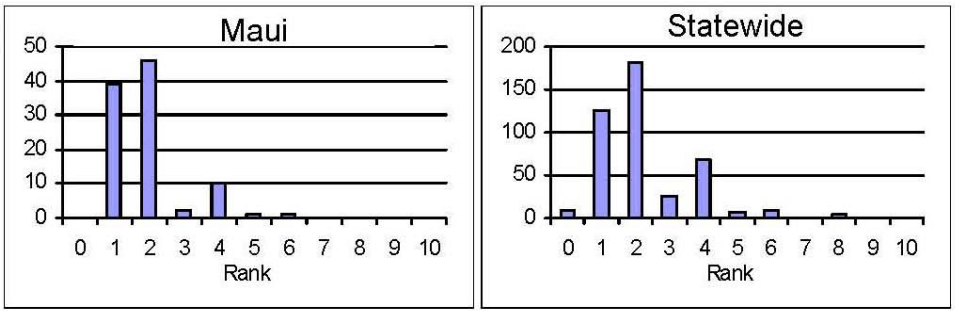
6



WATERSHED RATING (Cont): Waiohue, Maui

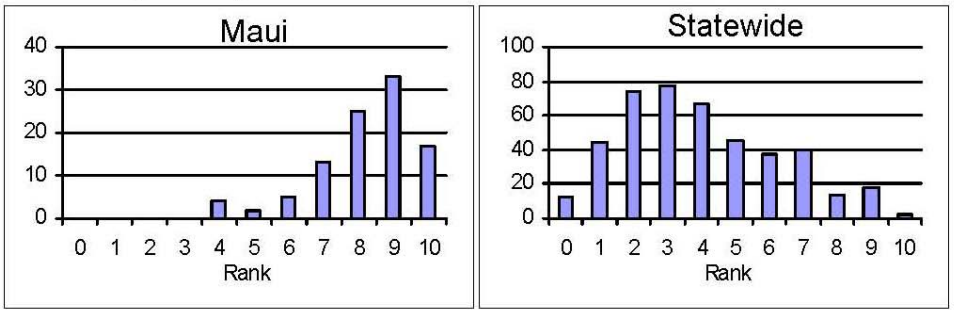
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.

Watershed Rating 1



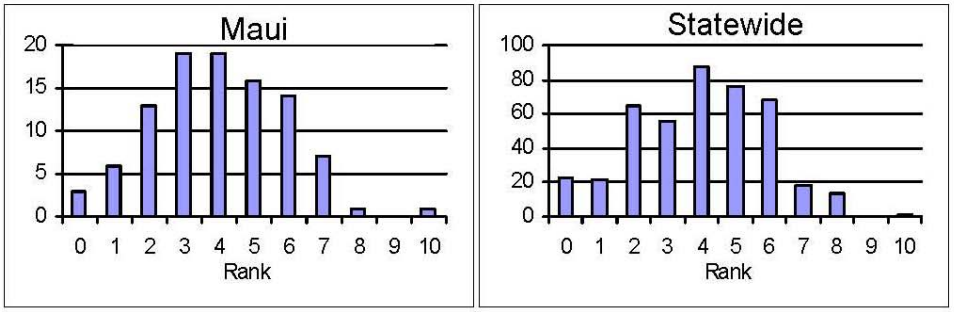
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.

Watershed Rating 10



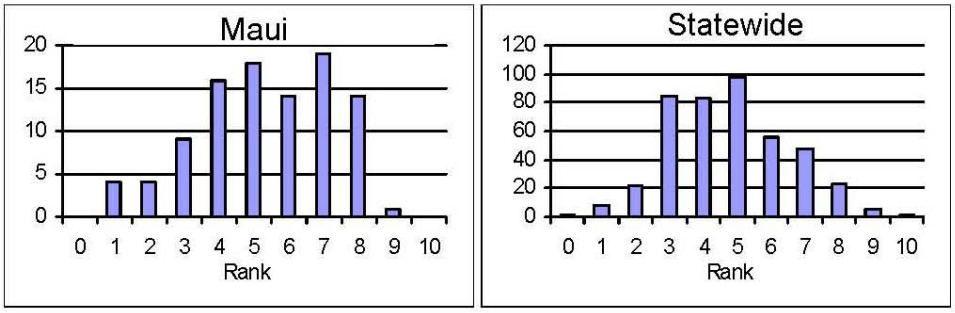
Reach Diversity Rating: Rating is based on the types and amounts of different stream reaches available in the watershed. More area in different reach types score more positively.

Watershed Rating 2



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.

Watershed Rating 7

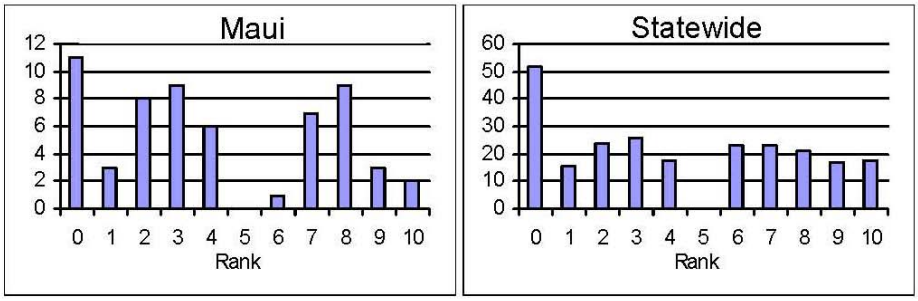


BIOLOGICAL RATING: Waiohue, Maui

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

Stream Rating

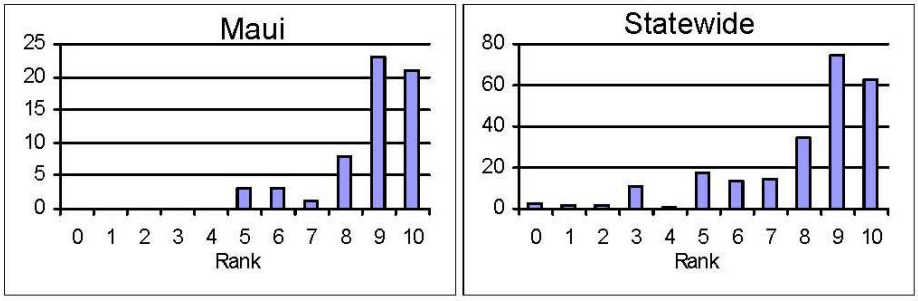
10



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

Stream Rating

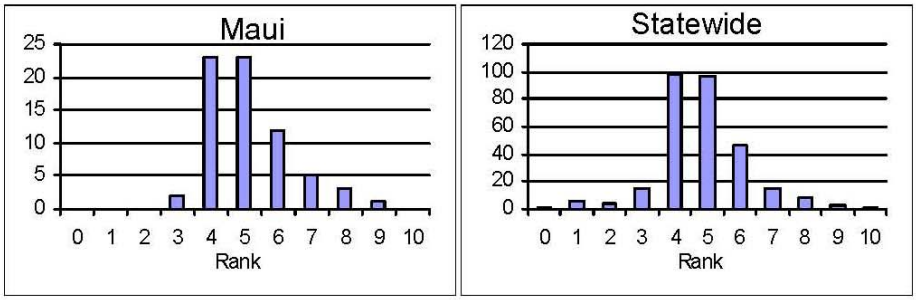
9



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

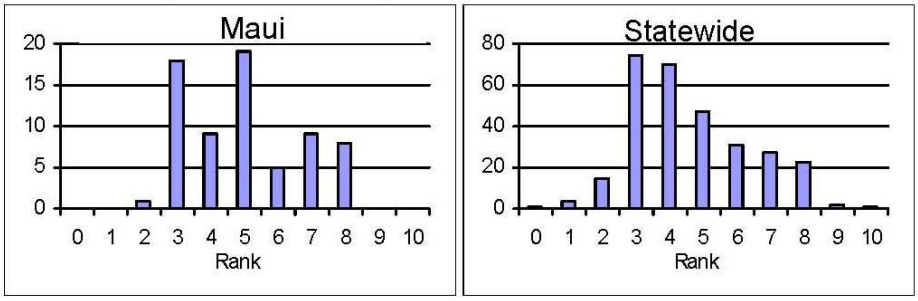
7



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

Stream Rating

8

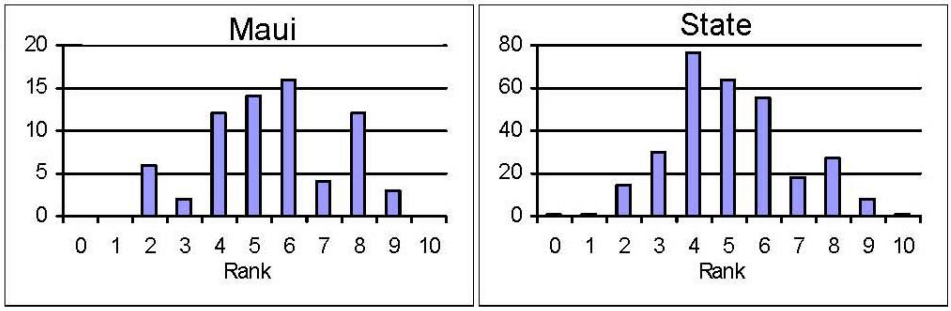


OVERALL RATING: Waiohue, Maui

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

Watershed Rating

8

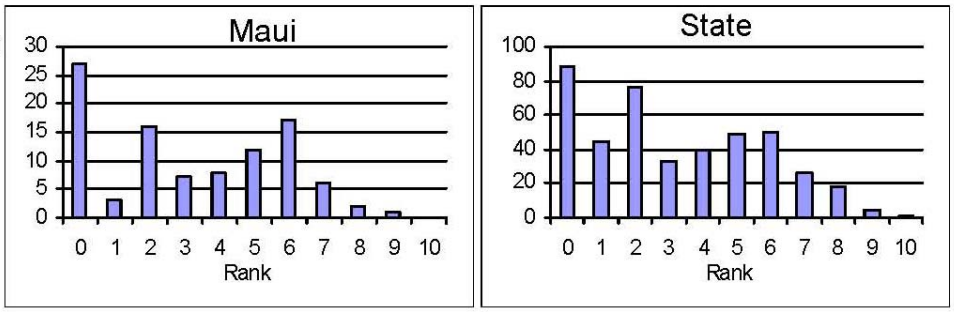


RATING STRENGTH: Waiohue, Maui

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.

Information Rating

7



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

Section 3: DAR Point Quadrat Report for Waiohue, Maui

For Surveys from 3/9/2009 to 5/14/2009

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:

Waiohue (ID: 64018), Ke‘anae, Maui

Surveys were conducted by these personnel:

Hau, Skippy
Kuamo‘o, Darrell
Sakihara, Troy
Shindo, Tim

Results

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

Reach	Total number of surveys
Estuary	2
Lower	3
Middle	1
Upper	17
Headwaters	0
Unknown	0

Estuary

Table 3-2. Number of Habitat Types surveyed in the estuary.

Reach	Total Habitats Surveyed	Plunge Pool	Cascade	Riffle	Run	Pool	Side Pool	No Water	Dirty Water	Unknown
Estuary	1	0	0	1	0	0	0	0	0	0

Table 3-3. Observed Substrates (%) in point quadrat samples in the estuary.

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Estuary	0	0	0	35	35	30	0

Table 3-4. Observed Water Quality in point quadrat samples in the estuary.

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Estuary	20.54	0.096	7.42	8.36

Table 3-5. Summary of species observed in the estuary.

Category	Status	*Scientific Name*
Fish	Endemic	*Sicyopterus stimpsoni*
Fish	Endemic	*Kuhlia xenura*

Table 3-6. Average Density and Total number of animals observed in the estuary. 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.

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Fish	Endemic	*Sicyopterus stimpsoni*	Estuary	2.95	1

Lower Reach

Table 3-7. 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
Lower	3	0	0	0	3	0	0	0	0	0

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

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Lower	0	0	0	23	20	57	0

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

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Lower	20.397	0.095	7.037	7.94

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

Category	Status	*Scientific Name*
Crustacean	Introduced	*Macrobrachium lar*
Fish	Indigenous	*Awaous guamensis*
Snail	Endemic	*Neritina granosa*

Table 3-11. 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.

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Fish	Indigenous	*Awaous guamensis*	Lower	2.1	2
Snails	Endemic	*Neritina granosa*	Lower	165.0	157

Middle Reach

Table 3-12. Number of Habitat Types surveyed in the middle stream reach.

Reach	Total Habitats Surveyed	Plunge Pool	Cascade	Riffle	Run	Pool	Side Pool	No Water	Dirty Water	Unknown
Middle	1	1	0	0	0	0	0	0	0	0

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

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Middle	0	0	10	15	15	60	0

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

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Middle	20.38	0.095	7.04	7.99

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

Category	Status	*Scientific Name*
Crustacean	Introduced	*Macrobrachium lar*
Fish	Endemic	*Sicyopterus stimpsoni*
Fish	Indigenous	*Awaous guamensis*
Snail	Endemic	*Neritina granosa*

Upper Reach

Table 3-16. Number of Habitat Types surveyed in the upper stream reach.

Reach	Total Habitats Surveyed	Plunge Pool	Cascade	Riffle	Run	Pool	Side Pool	No Water	Dirty Water	Unknown
Upper	14	2	0	3	3	5	0	1	0	0

Table 3-17. Observed Substrates (%) in point quadrat samples in the upper stream reach

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Upper	1	0	0	16	21	20	42

Table 3-18. Observed Water Quality in point quadrat samples in the upper stream reach.

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Upper	17.743	0.046	7.732	7.439

Table 3-19. Summary of species observed in the upper reach of the watershed.

Category	Status	*Scientific Name*
Crustacean	Endemic	*Atyoida bisulcata*

Table 3-20. 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.

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Crustaceans	Endemic	*Atyoida bisulcata*	Upper	8.1	51

Table 3-21. Flow data taken during point quadrat in the estuary.

Latitude	Longitude	Total CFS	MGD
20.82666	-156.11543	2.25	1.45

Table 3-22. Flow data taken during point quadrat in the lower stream reach.

Latitude	Longitude	Total CFS	MGD
20.82617	-156.11673	2.5	1.61

Table 3-23. Flow data taken during point quadrat in the upper stream reach.

Latitude	Longitude	Total CFS	MGD	Location
20.81639	-156.12587	0.22	0.14	Below Diversion
20.81452	-156.12657	7.66	4.95	Above Diversion
20.80724	-156.12689	1.73	1.12	Far Above Diversion

Summary

Surveys were conducted in Waiohue Stream on March 9, May 11 and 14, 2009. A total of 843 m of stream length was surveyed in three discrete sections (203 m, 294 m, 346 m). Water flow data was collected at 5 sites and one diversion was observed within the survey area in the upper reach above Hāna Highway.

Animal species observed in Waiohue Stream during 11 March, and 11 and 14 May 2009 surveys:

In the Estuary Reach:

Category	Status	*Scientific Name*
Fish	Endemic	*Sicyopterus stimpsoni*
Fish	Endemic	*Kuhlia xenura*

In the Lower Reach:

Category	Status	*Scientific Name*
Crustacean	Introduced	*Macrobrachium lar*
Fish	Indigenous	*Awaous guamensis*
Snail	Endemic	*Neritina granosa*

In the Middle Reach:

Category	Status	*Scientific Name*
Crustacean	Introduced	*Macrobrachium lar*
Fish	Endemic	*Sicyopterus stimpsoni*
Fish	Indigenous	*Awaous guamensis*
Snail	Endemic	*Neritina granosa*

In the Upper Reach:

Category	Status	*Scientific Name*
Crustacean	Endemic	*Atyoida bisulcata*

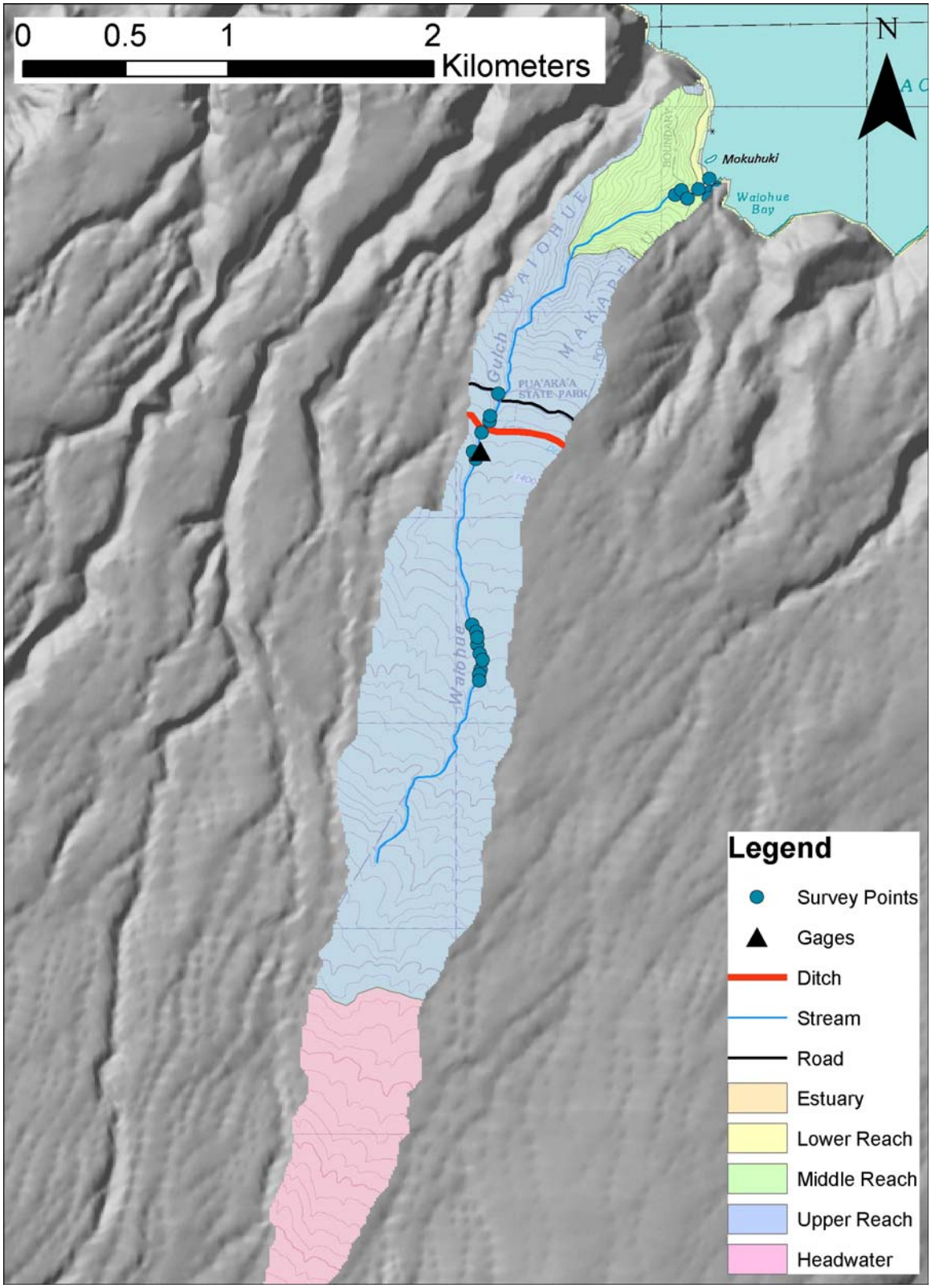


Figure 3-1. Locations of point quadrat surveys conducted in Waiohue Stream.

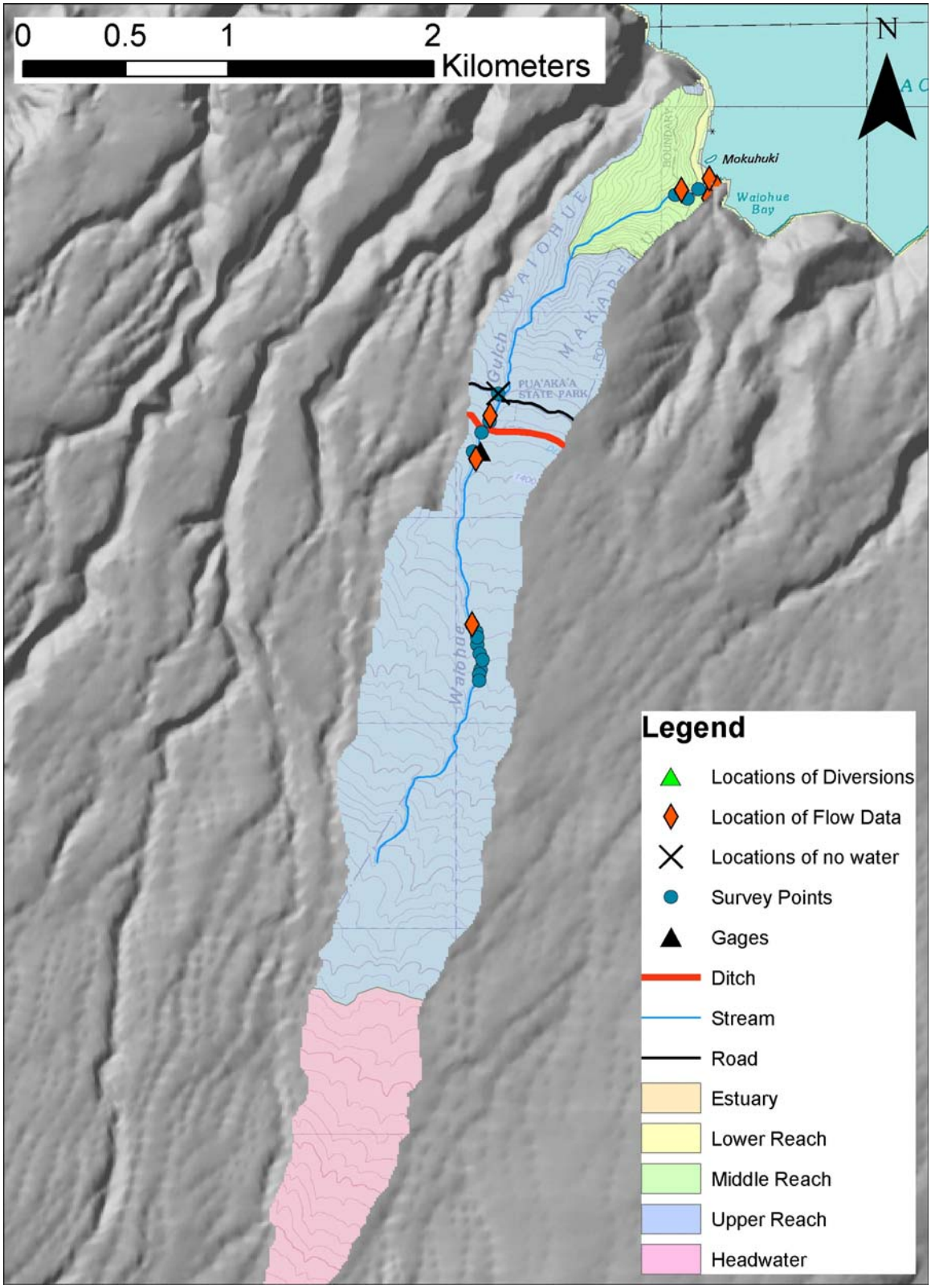


Figure 3-2. Locations of diversion, flow data and no flow surveys conducted in Waiohue Stream.

Estuary, Lower and Middle Reaches

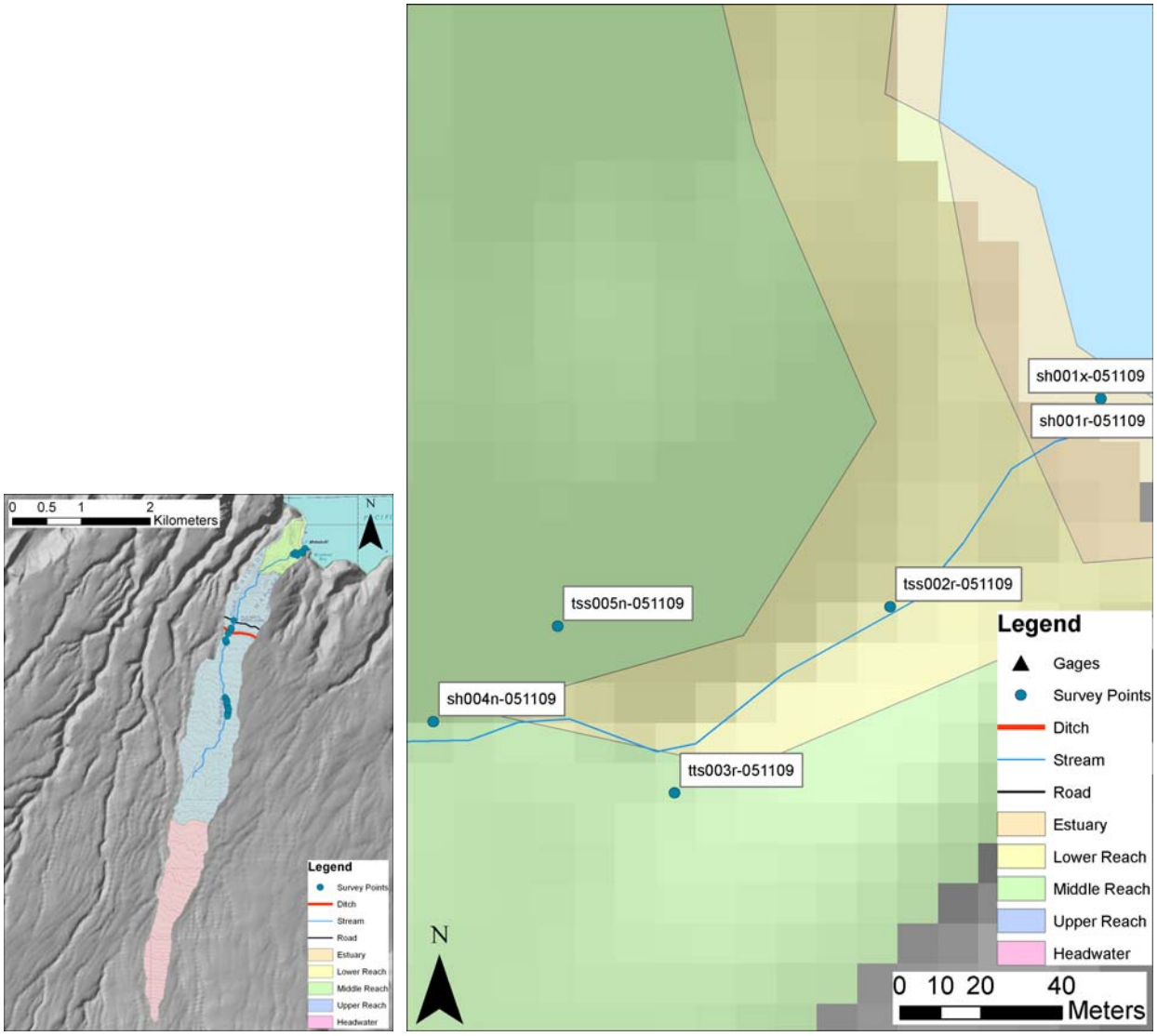
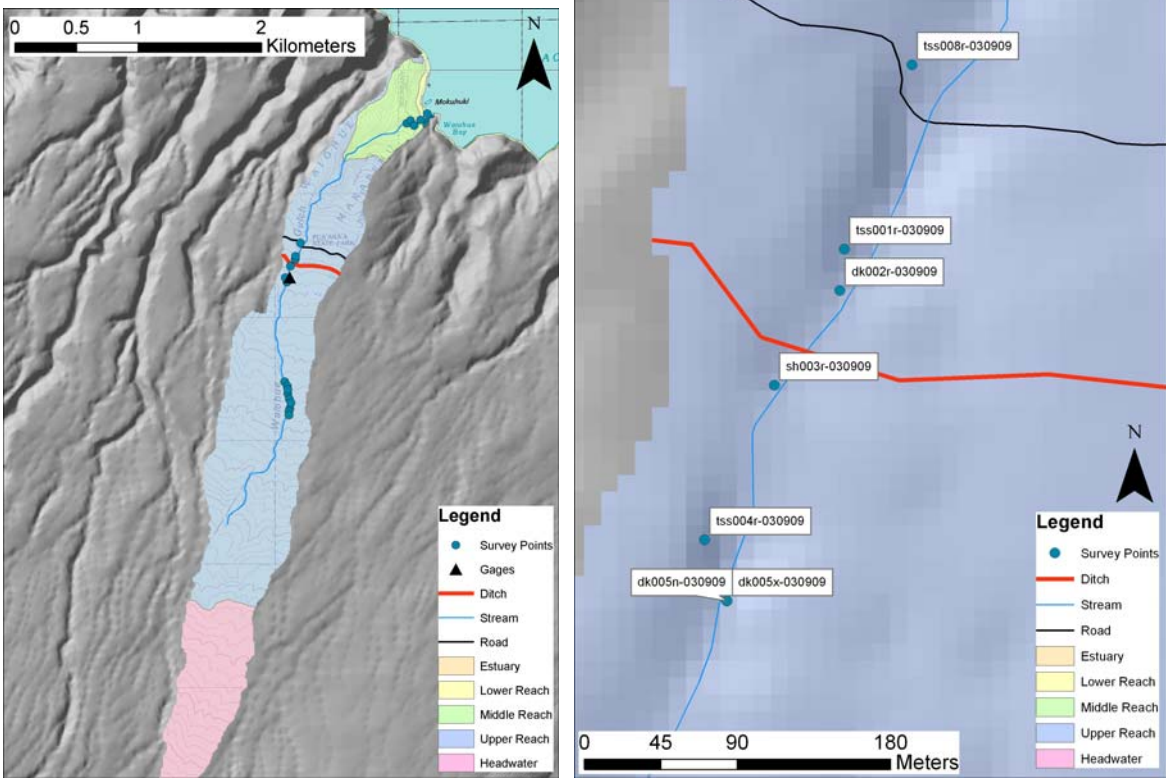


Figure 3-3. Point quadrat survey locations in the estuary, lower, and middle reaches of Waiohue Stream.

Upper Reach


0 0.5 1 2 Kilometers
N
Legend
Survey Points
Gages
Ditch
Stream
Road
Estuary
Lower Reach
Middle Reach
Upper Reach
Headwater
tss008r-030909
tss001r-030909
dk002r-030909
sh003r-030909
tss004r-030909
dk005n-030909
dk005x-030909
0 45 90 180 Meters

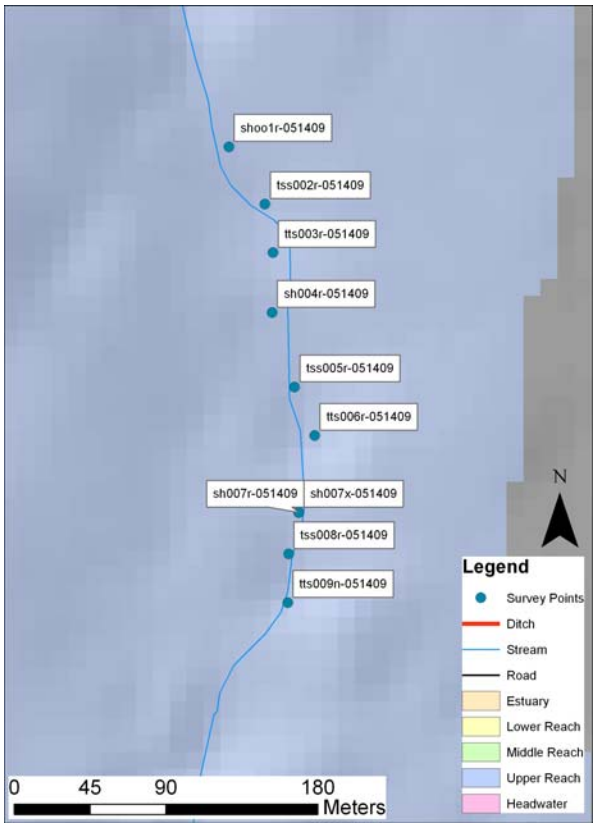


Figure 3-4. Point quadrat survey locations in the upper reach of Waiohue Stream.

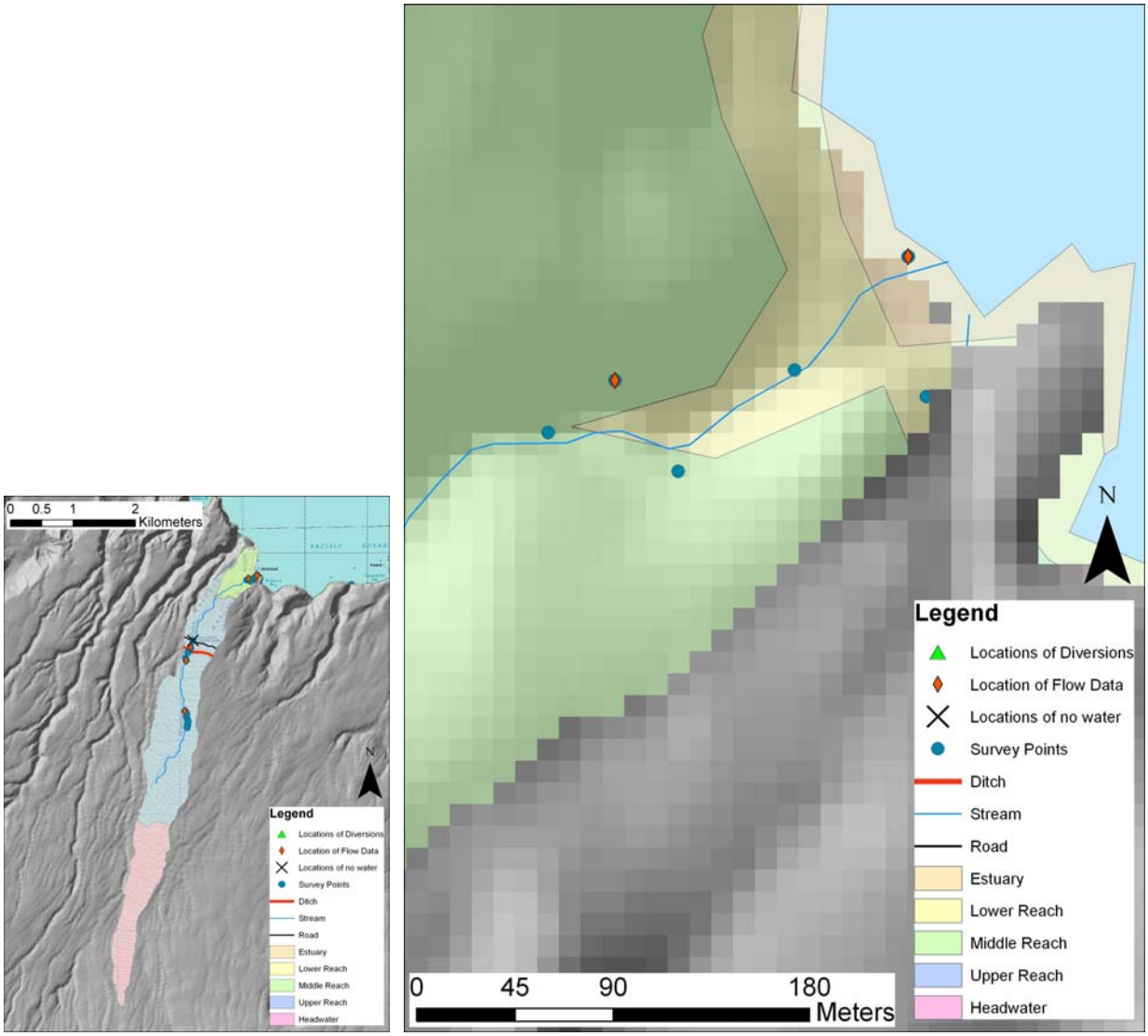


Figure 3-5. Locations of diversions, flow data and no water conditions in the estuary, lower, and middle reaches of Waiohue Stream.

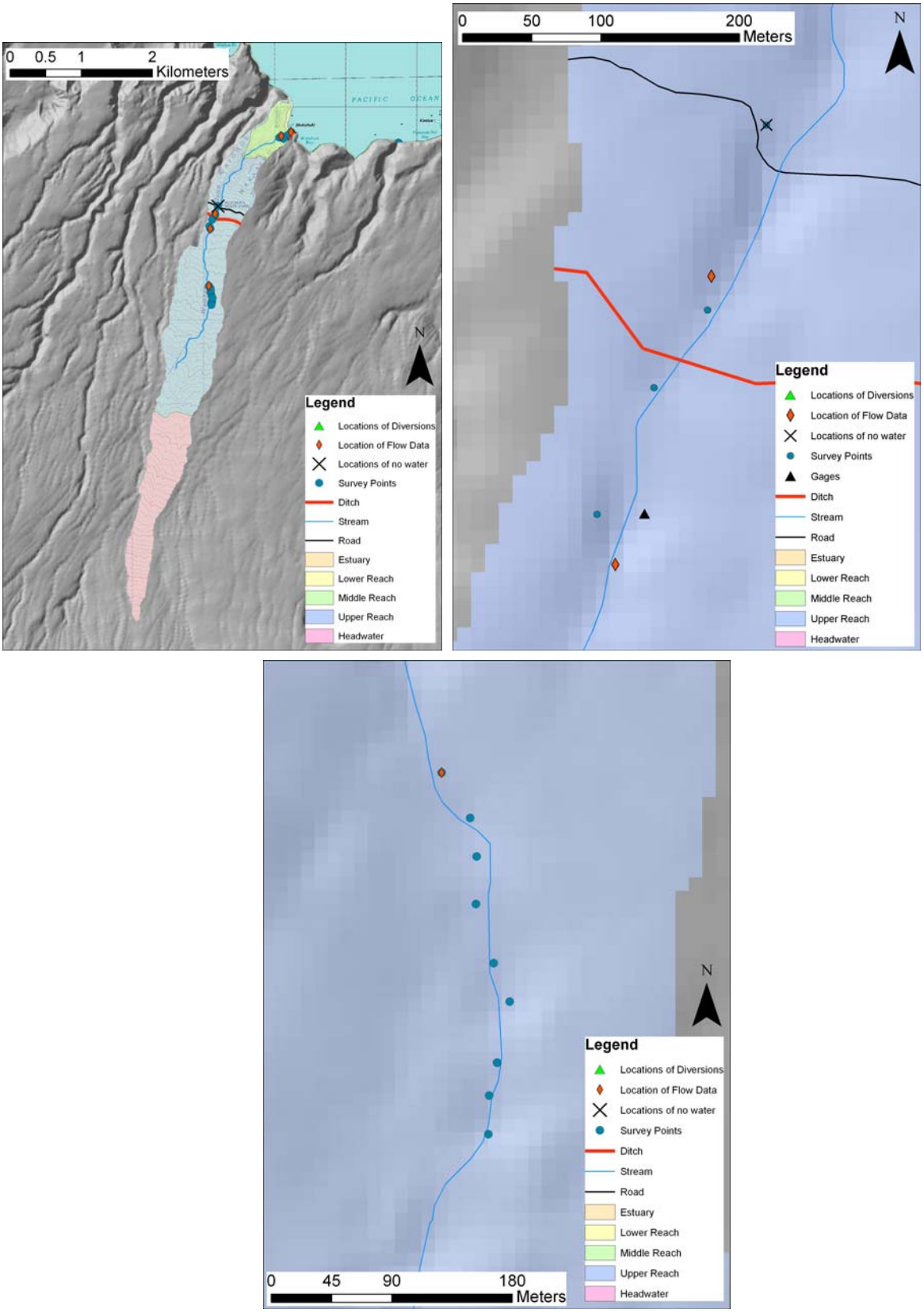


Figure 3-6. Locations of diversions, flow data, and no water conditions in the upper reach of Waiohue Stream.

Section 4: DAR Estuary Survey Report for Waiohue, Maui

For Surveys Conducted on: 5/11/2009

Introduction

This is a report of the Hawaii Division of Aquatic Resources estuary survey conducted in Waiohue 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 Waiohue Stream to investigate the effect of stream conditions on the native biota in the stream and estuarine habitat of Waiohue 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 Waiohue 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, Waiohue, is located in the region of Ke‘anae, Maui. The watershed (and watershed ID), region, and island surveyed in this report

Waiohue (ID: 64018), Ke‘anae, Maui

Surveys were completed by these DAR staff:

Hau, Skippy
Sakihara, Troy
Shindo, Timothy

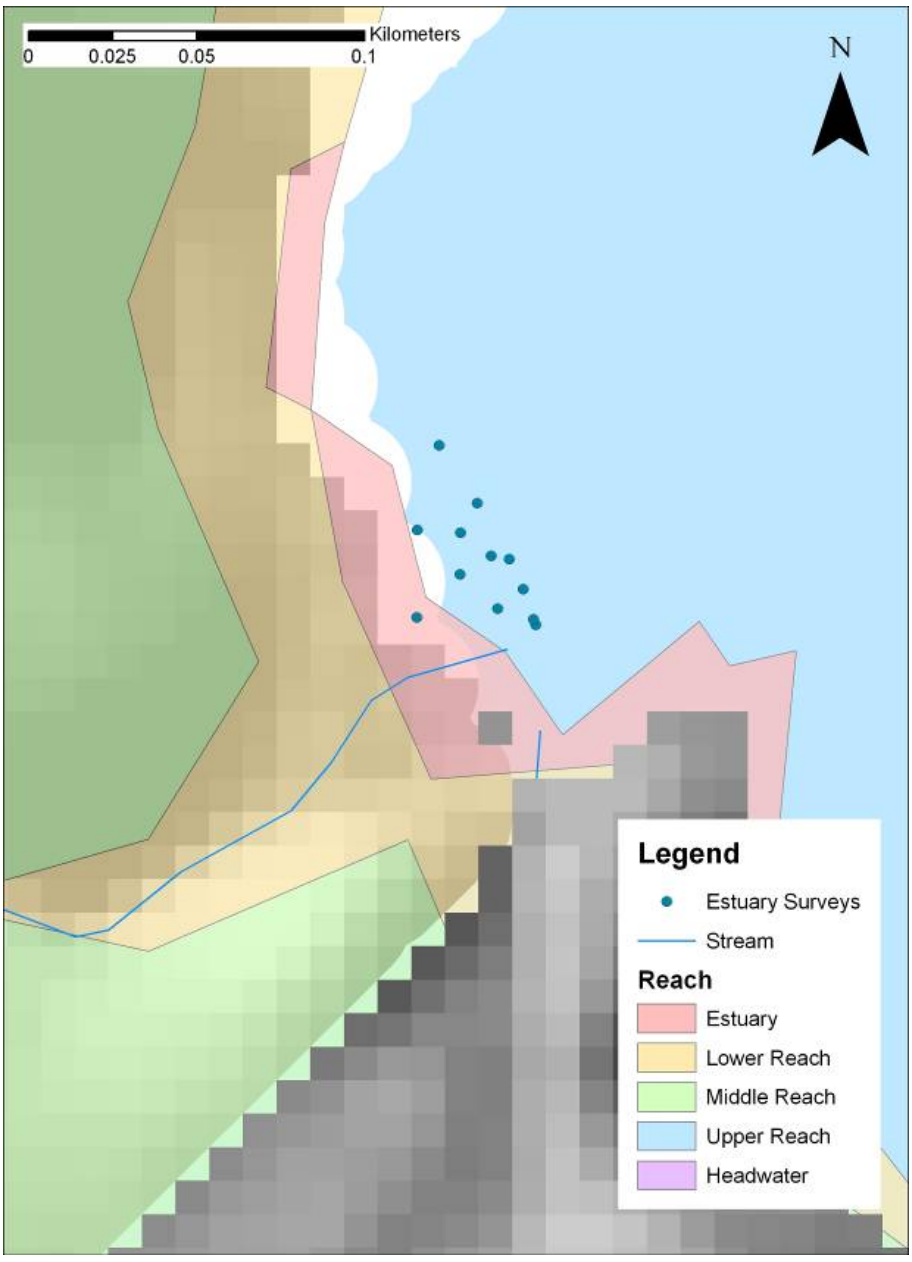


Figure 4-1. Location of estuary surveys conducted in Waiohue.

Results

Table 4-1. Summary of estuary classification and habitat description in Waiohue, Maui.

Location	Location ID	Estuary Status	Estuary Type	Reach	Habitat Type(s)
Waiohue	17	Natural	Coastal Embayment	Lower	Boulder

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

Avg Detritus	Avg Sediment	Avg Sand	Avg Gravel	Avg Cobble
0	0	22	23	23
Avg Boulder	**Avg Bedrock**	**Avg Emergent Veg**	**Avg Submergent Veg**	**Avg Coral**
32	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 Waiohue.

Location	Location ID	Depth min (cm)	Depth max (cm)	Depth avg (cm)	Depth Std dev. (cm)
Waiohue	17	25	51	27	5.46

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

Location	Location ID	DO min (mg/L)	DO max (mg/L)	DO avg. (mg/L)	DO Std. Dev. (mg/L)
Waiohue	17	4.88	6.86	6.66	0.53

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

Location	Location ID	pH min	pH max	pH avg.	pH Std. Dev.
Waiohue	17	7.88	8.28	8.24	0.12

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

Location	Location ID	Salinity min (ppt)	Salinity max (ppt)	Salinity avg. (ppt)	Salinity Std. Dev. (ppt)
Waiohue	17	2.69	35.24	5.55	8.05

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

Location	Location ID	Temp min (° C)	Temp max (° C)	Temp avg. (° C)	Temp Std. Dev. (° C)
Waiohue	17	21.47	23.78	22.31	0.33

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

Location	Location ID	Number of Surveys	Species	Category	Status	# of animals
Waiohue	17	12	*Abudefduf sordidus*	Fish	Indigenous	3
			Kuhlia xenura	Fish	Endemic	130

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.
Abudefduf sordidus	Fish	3	155	94	134	34.66
Kuhlia xenura	Fish	130	125	38	57	18.96

Summary

Estuary Surveys were conducted in the estuary reach of Waiohue. A total of 90m of shoreline was surveyed in 1 discrete section. The physical characteristics of Waiohue estuary consisted of boulder terrain, white water and high surge. The mouth of Waiohue Stream had minimal flow entering the ocean into a small coastal embayment, typical of East Maui, which may very likely be the effects of diverted water upstream. The species collected in the samples reflected the habitat conditions with species that are common in areas of shallow white water and high surge.

Species observed in Waiohue Estuary:

Native Species

Fish *Abudefduf sordidus*, Kūpīpī
Kuhlia xenura, Āholehole

Section 5: Photographs taken during stream surveys

Estuary

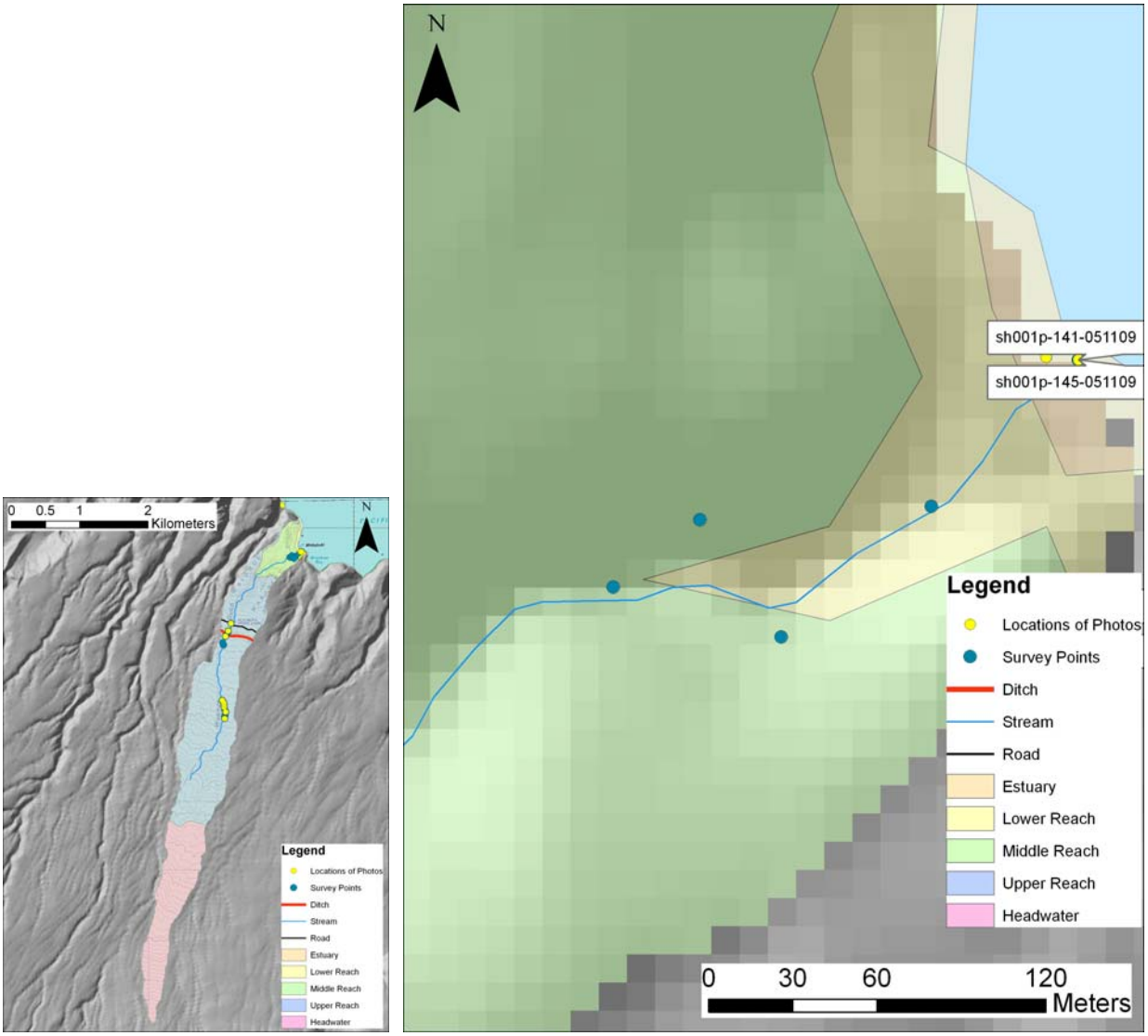


Figure 5-1. Photo locations in the estuary, lower, and middle reaches of Waiohue Stream.

Figure 5-2. Photo of Waiohue stream entering the ocean. (4/8/2009; Tributary name: Waiohue (64018001); PBN: dk64018001p-004-040809; Surveyor: Kuamo‘o, D.).

Figure 5-3. Upstream view of Waiohue stream. (4/8/2009; Tributary name: Waiohue (64018001); PBN: dk64018001-001-040809; Surveyor: Kuamo‘o, D.).

Figure 5-4. Eastward view of the stream mouth. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-054-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

Figure 5-5. View of boulder beach at Waiohue stream mouth (right) at low tide. Photo taken eastward. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-064-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

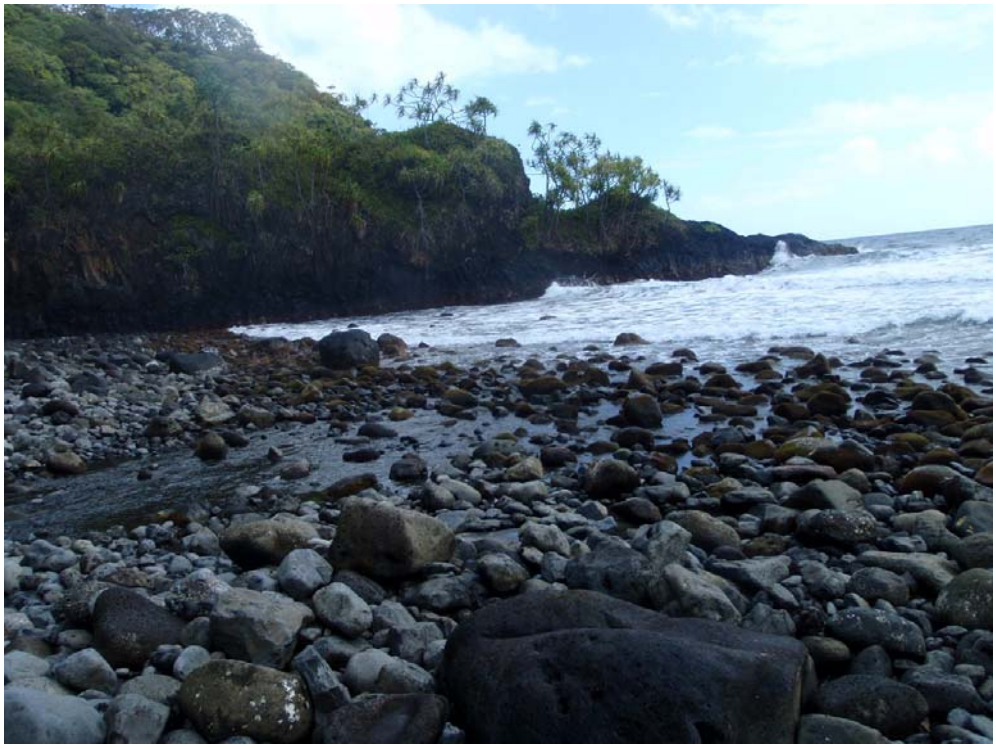


Figure 5-6. Westward view of the stream mouth. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-066-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

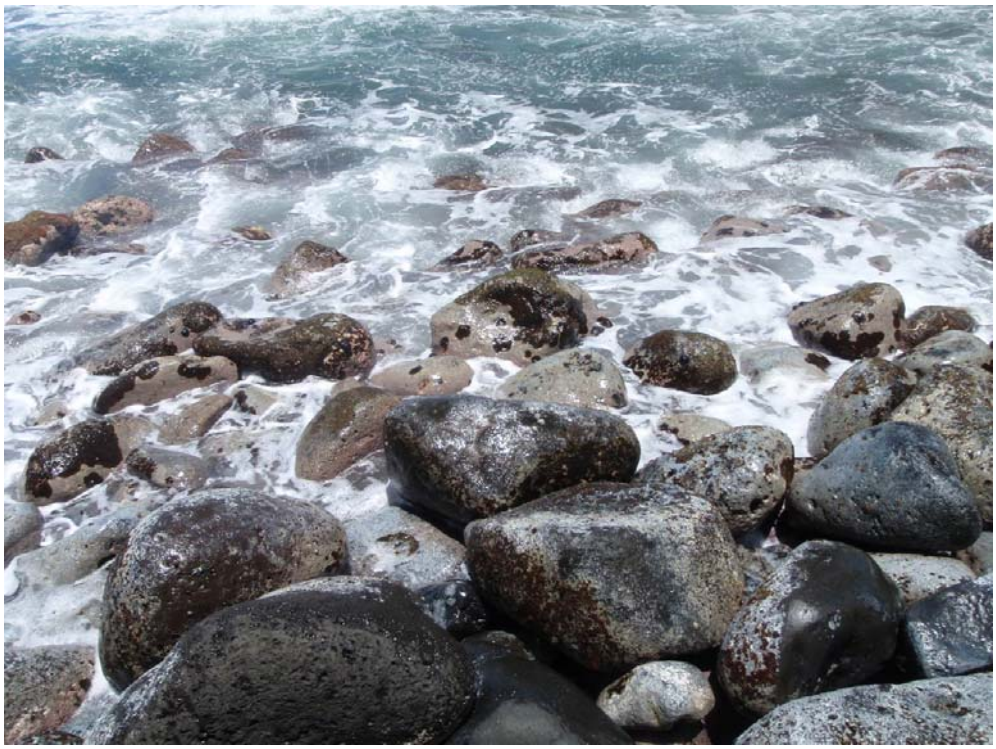


Figure 5-7. View of boulder shoreline and habitat sampled in Waiohue right side of stream mouth. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-098-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

Figure 5-8. DAR Surveyor measuring a Kūpīpī (*Abudefduf sordidus*), a species commonly found in shallow areas with high surge. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-107-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

Figure 5-9. A collected sample of āholehole (*Kuhlia xenura*) to be measured; one of the most common estuarine species throughout the state. Caught right at stream mouth. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-117-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

Figure 5-10. DAR surveyor conducting sampling on boulder beach immediately west of Waiohue stream mouth at high tide. Photo oriented westward. (5/11/2009; Tributary name: Waiohue (64018001); PBN: tts64018001p-128-051109; Lat. (DD): 20.82667, Long. (DD): -156.11554).

Figure 5-11. Survey site 1 at stream mouth of Waiohue Stream. (5/11/2009; Tributary name: Waiohue (64018001); PBN: sh001p-141-051109; Surveyor: Hau, S.; Habitat type: Riffle; SBN: sh001r-051109; Lat. (DD): 20.82666, Long. (DD): -156.11543).

Figure 5-12. Photo of stream bed with algal mats near site 1 at stream mouth in Waiohue Stream. (5/11/2009; Tributary name: Waiohue (64018001); PBN: sh001p-145-051109; Surveyor: Hau, S.; Habitat type: Riffle; SBN: sh001r-051109; Lat. (DD): 20.82666, Long. (DD): -156.11543).

Upper Reach

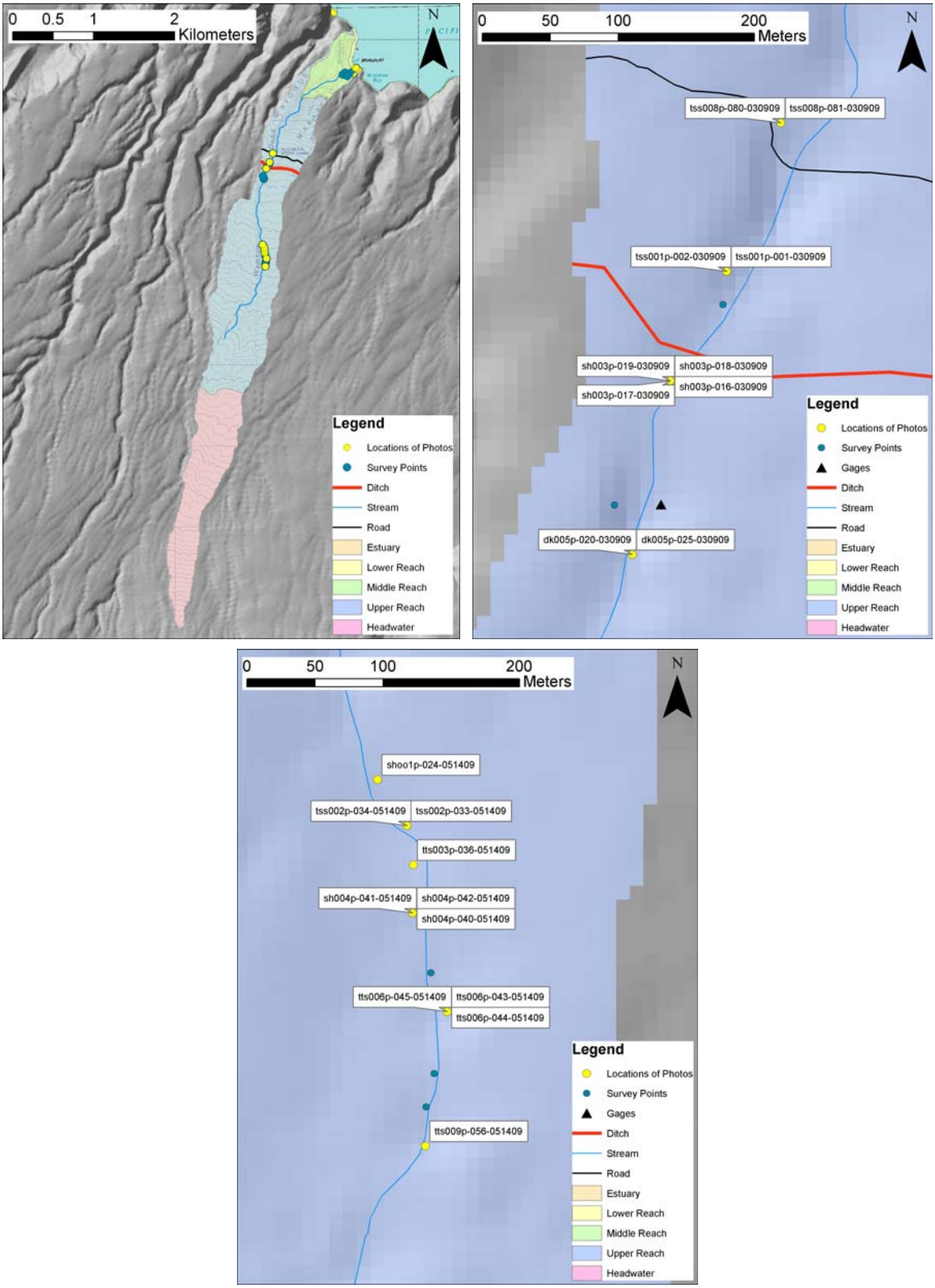


Figure 5-13. Photo locations in the upper reach of Waiohue Stream.

Figure 5-14. Photo of waterfall at the intersection of Hāna Highway Bridge and Waiohue at survey site 8. Below diversion showing the low flow in the stream. (3/9/2009; Tributary name: Waiohue (64018001); PBN: tss008p-080-030909; Surveyor: Sakihara, T.; Habitat type: No Water; SBN: tss008r-030909; Lat. (DD): 20.81737, Long. (DD): -156.12547).

Figure 5-15. Photo taken at the intersection of Hāna Highway bridge (above highway) and Waiohue Stream at survey site 8. Image is taken in an upstream direction. (3/9/2009; Tributary name: Waiohue (64018001); PBN: tss008p-081-030909; Surveyor: Sakihara, T.; Habitat type: No Water; SBN: tss008r-030909; Lat. (DD): 20.81737, Long. (DD): -156.12547).

Figure 5-16. Photo taken from waterfall Pua‘a Ka‘a State Wayside above Hāna Highway in the downstream direction from survey site 1. (3/9/2009; Tributary name: Waiohue (64018001); PBN: tss001p-002-030909; Surveyor: Sakihara, T.; Habitat type: Pool; SBN: tss001r-030909; Lat. (DD): 20.81639, Long. (DD): -156.12587).

Figure 5-17. Photo of survey site 1 in pool taken in upstream direction. (3/9/2009; Tributary name: Waiohue (64018001); PBN: tss001p-001-030909; Surveyor: Sakihara, T.; Habitat type: Pool; SBN: tss001r-030909; Lat. (DD): 20.81639, Long. (DD): -156.12587).

Figure 5-18. Photo of dry downstream channel below diversion intake. showing where the natural stream exits from the pool. Note the low flow due to the diversion. (3/9/2009; Tributary name: Waiohue (64018001); PBN: sh003p-019-030909; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh003r-030909; Lat. (DD): 20.81567, Long. (DD): -156.12628).

Figure 5-19. Photo of concrete wall damming water for diversion intake above survey site 3. (3/9/2009; Tributary name: Waiohue (64018001); PBN: sh003p-016-030909; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh003r-030909; Lat. (DD): 20.81567, Long. (DD): -156.12628).

Figure 5-20. Photo of the intake where the water exits the dammed pool into the ditch system diverting 100% of flow. (3/9/2009; Tributary name: Waiohue (64018001); PBN: sh003p-018-030909; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh003r-030909; Lat. (DD): 20.81567; Long. (DD): -156.12628).

Figure 5-21. Photo of dammed waterfall plunge pool where diversion intake (to the left) is located above survey site 3. (3/9/2009: Tributary name: Waiohue (64018001); PBN: sh003p-017-030909; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh003r-030909; Lat. (DD): 20.81567, Long. (DD): -156.12628).

Figure 5-22. Flow measurement site. (3/9/2009: Tributary name: Waiohue (64018001); PBN: dk005p-025-030909; Surveyor: Kuamo‘o, D.; Habitat type: Run; SBN: dk005n-030909; Lat. (DD): 20.81452, Long. (DD): -156.12657).

Figure 5-23. Photo of second waterfall. (3/9/2009: Tributary name: Waiohue (64018001); PBN: dk005p-020-030909; Surveyor: Kuamo‘o, D.; Habitat type: Plunge Pool; SBN: dk005n-030909; Lat. (DD): 20.81452, Long. (DD): -156.12657).

Figure 5-24. Photo shows DAR staff conducting flow measurements. (5/14/2009; Tributary name: Waiohue (64018001); PBN: sh001p-024-051409; Surveyor: Hau, S.; SBN: 118; Lat. (DD): 20.80724, Long. (DD): -156.12689).

Figure 5-25. Photo shows a pool upstream of survey site 2 with algal patches. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tss002p-033-051409; Surveyor: Sakihara, T.; Habitat type: Pool, SBN: tss002r-051409; Lat. (DD): 20.80693, Long. (DD): -156.12669) *Atyoida bisulcata* present - water dripping from stream walls.

Figure 5-26. Photo shows downstream of survey site 2. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tss002p-034-051409; Surveyor: Sakihara, T.; Habitat type: Pool; SBN: tss002r-051409; Lat. (DD): 20.80693, Long. (DD): -156.12669).

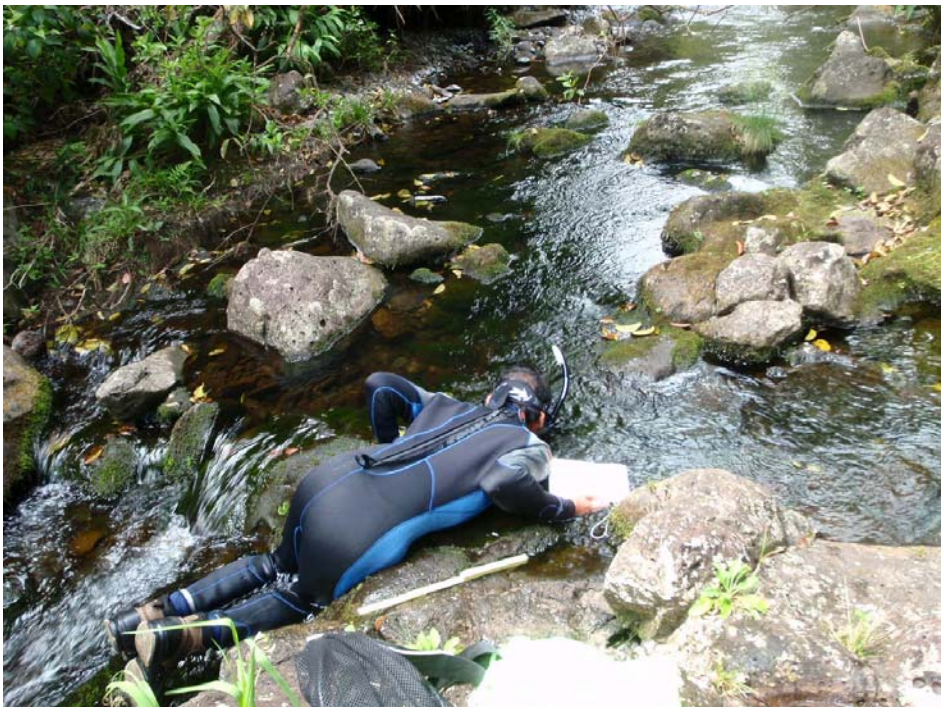


Figure 5-27. Photo shows DAR staff surveying site 3. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tts003p-036-051409; Surveyor: Shindo, T.; Habitat type: Run; SBN: tts003r-051409; Lat. (DD): 20.80667, Long. (DD): -156.12665).

Figure 5-28. Photo is oriented in a downstream direction from the survey site 4. (5/14/2009; Tributary name: Waiohue (64018001); PBN: sh004p-042-051409; Surveyor: Hau, S.; Habitat type: Riffle; SBN: sh004r-051409; Lat. (DD): 20.80635, Long. (DD): -156.12666).

Figure 5-29. Photo is taken in an upstream direction from the survey site 4. (5/14/2009; Tributary name: Waiohue (64018001); PBN: sh004p-041-051409; Surveyor: Hau, S.; Habitat type: Riffle; SBN: sh004r-051409; Lat. (DD): 20.80635, Long. (DD): -156.12666).

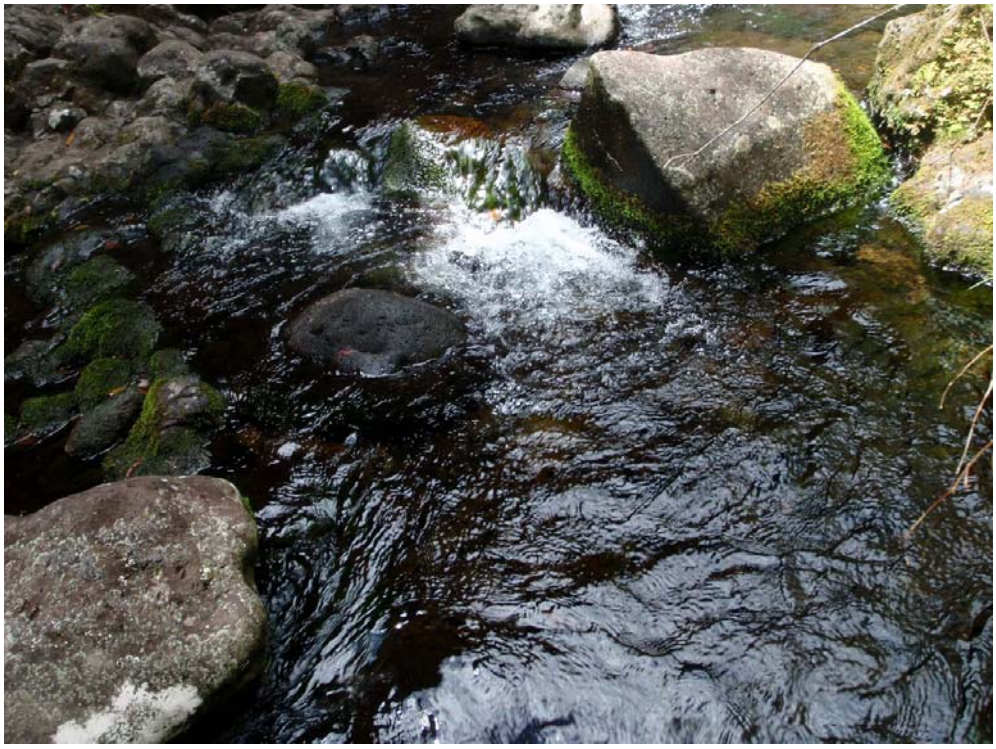


Figure 5-30. Photo shows survey site 4. (5/14/2009; Tributary name: Waiohue (64018001); PBN: sh004p-040-051409; Surveyor: Hau, S.; Habitat type: Riffle; SBN: sh004r-051409; Lat. (DD): 20.80635, Long. (DD): -156.12666).

Figure 5-31. Photo shows downstream of survey site 6. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tts006p-045-051409; Surveyor: Shindo, T.; Habitat type: Riffle; SBN: tts006r-051409; Lat. (DD): 20.80569, Long. (DD): -156.12643).

Figure 5-32. Photo shows DAR staff conducting a survey at site 6. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tts006p-043-051409; Surveyor: Shindo, T.; Habitat type: Riffle; SBN: tts006r-051409; Lat. (DD): 20.80569, Long. (DD): -156.12643).

Figure 5-33. Photo shows upstream of survey site 6. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tts006p-044-051409; Surveyor: Shindo, T.; Habitat type: Riffle; SBN: tts006r-051409; Lat. (DD): 20.80569, Long. (DD): -156.12643).

Figure 5-34. DAR surveyor conducting a non-random survey in a waterfall plunge pool in the last survey site 9 in upper reach of Waiohue Stream. (5/14/2009; Tributary name: Waiohue (64018001); PBN: tts009p-056-051409; Surveyor: Shindo, T.; Habitat type: Plunge Pool; SBN: tts009n-051409; Lat. (DD): 20.80480, Long. (DD): -156.1266).

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Appendix: Survey Sites Latitude and Longitude

Tributary	Stream	Survey Book #	Site	Surveyor	Date	Latitude	Longitude
64018001	Waiohue	dk005x-030909		Kuamo'o, Darrell	3/9/2009	20.81452	-156.12657
64018001	Waiohue	tss001r-030909	1	Sakihara, Troy	3/9/2009	20.81639	-156.12587
64018001	Waiohue	dk002r-030909	2	Kuamo'o, Darrell	3/9/2009	20.81617	-156.12590
64018001	Waiohue	sh003r-030909	3	Hau, Skippy	3/9/2009	20.81567	-156.12628
64018001	Waiohue	tss004r-030909	4	Sakihara, Troy	3/9/2009	20.81485	-156.12669
64018001	Waiohue	dk005n-030909	5	Kuamo'o, Darrell	3/9/2009	20.81452	-156.12657
64018001	Waiohue	tss008r-030909	8	Sakihara, Troy	3/9/2009	20.81737	-156.12547
64018001	Waiohue	sh001x-051109		Hau, Skippy	5/11/2009	20.82666	-156.11543
64018001	Waiohue	sh001r-051109	1	Hau, Skippy	5/11/2009	20.82666	-156.11543
64018001	Waiohue	tss002r-051109	2	Sakihara, Troy	5/11/2009	20.82620	-156.11594
64018001	Waiohue	tts003r-051109	3	Shindo, Tim	5/11/2009	20.82579	-156.11646
64018001	Waiohue	sh004n-051109	4	Hau, Skippy	5/11/2009	20.82596	-156.11703
64018001	Waiohue	tss005n-051109	5	Sakihara, Troy	5/11/2009	20.82617	-156.11673
64018001	Waiohue	sh007x-051409		Hau, Skippy	5/14/2009	20.80528	-156.12653
64018001	Waiohue	shoo1r-051409	1	Hau, Skippy	5/14/2009	20.80724	-156.12689
64018001	Waiohue	tss002r-051409	2	Sakihara, Troy	5/14/2009	20.80693	-156.12669
64018001	Waiohue	tts003r-051409	3	Shindo, Tim	5/14/2009	20.80667	-156.12665
64018001	Waiohue	sh004r-051409	4	Hau, Skippy	5/14/2009	20.80635	-156.12666
64018001	Waiohue	tss005r-051409	5	Sakihara, Troy	5/14/2009	20.80595	-156.12654
64018001	Waiohue	tts006r-051409	6	Shindo, Tim	5/14/2009	20.80569	-156.12643
64018001	Waiohue	sh007r-051409	7	Hau, Skippy	5/14/2009	20.80528	-156.12653
64018001	Waiohue	tss008r-051409	8	Sakihara, Troy	5/14/2009	20.80506	-156.12659
64018001	Waiohue	tts009n-051409	9	Shindo, Tim	5/14/2009	20.80480	-156.12660

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