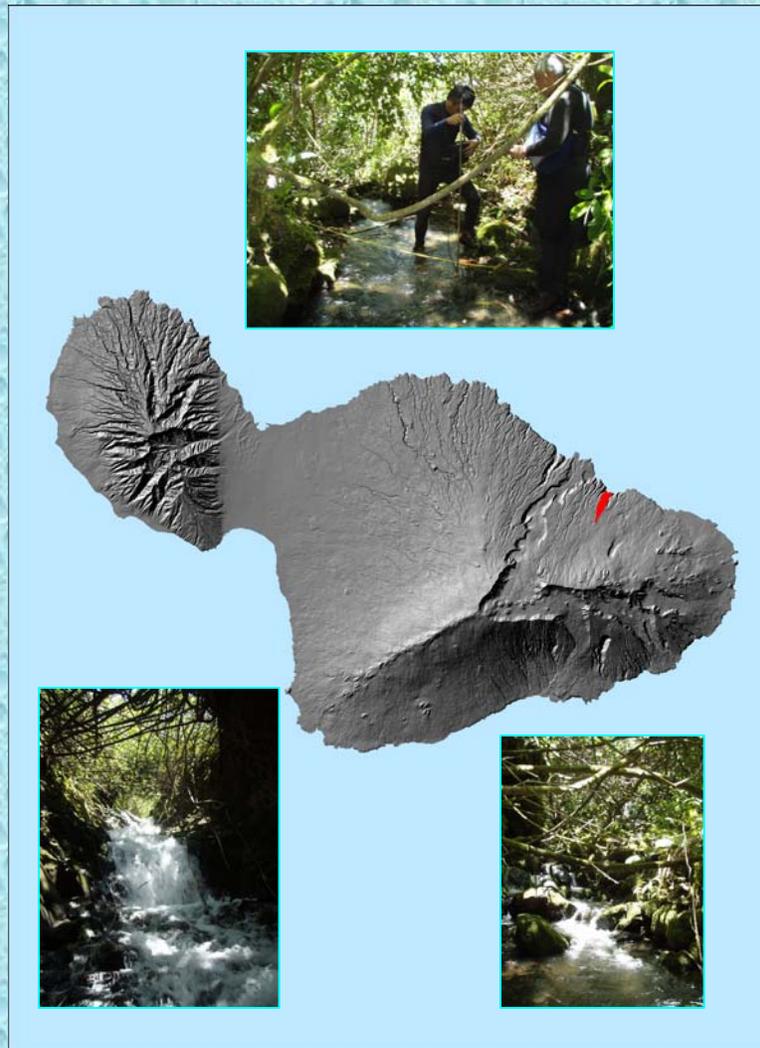


Report on Pa'akea Gulch Maui, Hawaii



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



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Report on Pa‘akea 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 Resources¹
Department of Land and Natural Resources
State of Hawai‘i
and
Bishop Museum²

Authors:

Glenn Higashi¹, James Parham², Eko Lapp¹, Skippy Hau¹, Darrell
Kuamo‘o¹, Lance Nishiura¹, Tim Shindo¹, Troy Sakihara¹,
Troy Shimoda¹, and Robert Nishimoto¹ and Dan Polhemus¹

Table of Contents

Section 1: Introduction	5
Overview.....	5
Findings for Pa‘akea Stream, Maui	6
Discussion.....	6
Section 2: Watershed Atlas	9
Watershed Features.....	9
Stream Features.....	10
Biotic Sampling Effort.....	11
Biota Information.....	11
Historic Rankings.....	12
Current Watershed and Stream Rating	14
Watershed Rating.....	14
Biological Rating	16
Overall Rating.....	17
Rating Strength	17
References.....	17
Section 3: DAR Point Quadrat Report	19
Introduction.....	19
Methods.....	19
Results.....	20
Lower Reach	20
Middle Reach	21
Upper Reach.....	22
Section 4: DAR Estuary Survey Report.....	31
Introduction.....	31
Materials and Methods.....	31
Results.....	33
Summary	34
Section 5: Photographs taken during stream surveys	35
Estuary and Lower Reach	35
Upper Reach.....	40
References.....	47
Appendix: Survey Sites Latitude and Longitude.....	49

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 Pa‘akea Stream, Maui from year 2000 to 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 Pa‘akea Stream while also providing substantial evidence to support the conclusions presented.

Findings for Pa'akea Stream, Maui

Pa'akea is a small (3.9 sq miles), narrow watershed that is steep in the upper sections with little embayment. It is zoned for conservation (70%) and agriculture (30%). The land cover is mostly evergreen forest (75%), scrub (11%), grassland (11%) and bare land (3%). Several stream surveys of different types have been completed in Pa'akea stream beginning in 1979 to the present. This watershed rates medium, 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 6 out of 10, a total biological rating of 6 out of 10, and a combined overall rating of 5 out of 10.

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

Fish - *Awaous guamensis*, *Eleotris sandwicensis*, *Kuhlia xenura*, *Lentipes concolor*, *Mugil cephalus* and *Sicyopterus stimpsoni*

Crustaceans - *Atyoida bisulcata*

Snails – *Neritina granosa*

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

Amphibian – *Bufo marinus* and *Rana rugosa*

Crustaceans - *Macrobrachium lar*

Discussion

Pa'akea Gulch is narrow, small and steep in the upper reaches with a very small embayment at the stream mouth. The stream was characterized by a series of plunge pools, riffles and runs. In the middle reach, the stream forks and has a tributary on the right. Pa'akea Gulch continues to the left into the upper reach of the watershed.

The mouth lower and middle reach of of Pa'akea Gulch was accessed by helicopter. The upper reach was accessed through East Maui Irrigation ditch roads via Hana Highway.

Pa'akea stream flowed into a small unprotected coastal embayment adjacent to Waiohue Stream, forming a very small estuary. Physical characteristics of Pa'akea estuary consisted of boulder terrain and moderate surf with white water. At the time of the estuary survey, the mouth of Pa'akea stream was open with very little flow entering the ocean. However, salinity levels remained relatively low throughout the survey sites, ranging from 9.24 ppt to 19.04 ppt.

A total of eight fish were recorded in Pa'akea estuary, with the most abundant being **āholehole**, *Kuhlia xenura* (n=6). *K. xenura* was caught in 9.24 ppt and *K. xenura*, Christmas wrasse, *Thalassoma trilobatum*, and **'iao**, *Atherinomorus insularum*, were caught in 19.04 ppt.

According to our data, Pa'akea estuary does not seem to be a biologically diverse estuarine habitat. One of the main reasons may be the lack of flow from Pa'akea stream, which could hinder recruitment of juvenile fish, invertebrates and larvae. Other factors include open ocean surge, wave action and the overall size of the estuary that may not provide adequate shelter for juvenile species from predation. However, the presence of juvenile *K. xenura*, which were only recorded in estuaries with open and flowing stream mouths in East Maui, may indicate the

potential that Pa‘akea stream mouth may provide a suitable habitat for juvenile *K. xenura* and possibly other estuarine species.

Point quadrat surveys were conducted in Pa‘akea Gulch in the lower and upper reaches. At the lower reach stream flowed to the ocean over a cobble and boulder substrate from a waterfall and plunge pool. Adult **‘o‘opu ‘akupa** (*Eleotris sandwicensis*), **hīhīwai** (*Neritina granosa*), and **‘o‘opu nōpili** (*Sicyopterus stimpsoni*) as well as postlarvae were observed inside the plunge pool as well as the section leading to the ocean. Access to stream was difficult above the first waterfall due to the steep stream banks and overgrown **hau**, *Hibiscus tiliaceus* however; *N. granosa*, **‘o‘opu nākea** (*Awaous guamensis*), *S. stimpsoni*, and **‘o‘opu ‘alamo‘o** (*Lentipes concolor*) were observed.

During the surveys above Hāna Highway the section below the first diversion had no flowing water, just standing pools. The stream consisted mostly of bedrock substrate below the ditch (Figure 5-11). The flow was diverted by a concrete weir that channeled 100% of the water through a control gate that led to the ditch (Figure 5-14). There were pools with minimal flow throughout the surveys above the diversion and the flow reading was taken at the last survey site (Figure 5-18). *Atyoida bisulcata* was the only stream species found above the diversion.

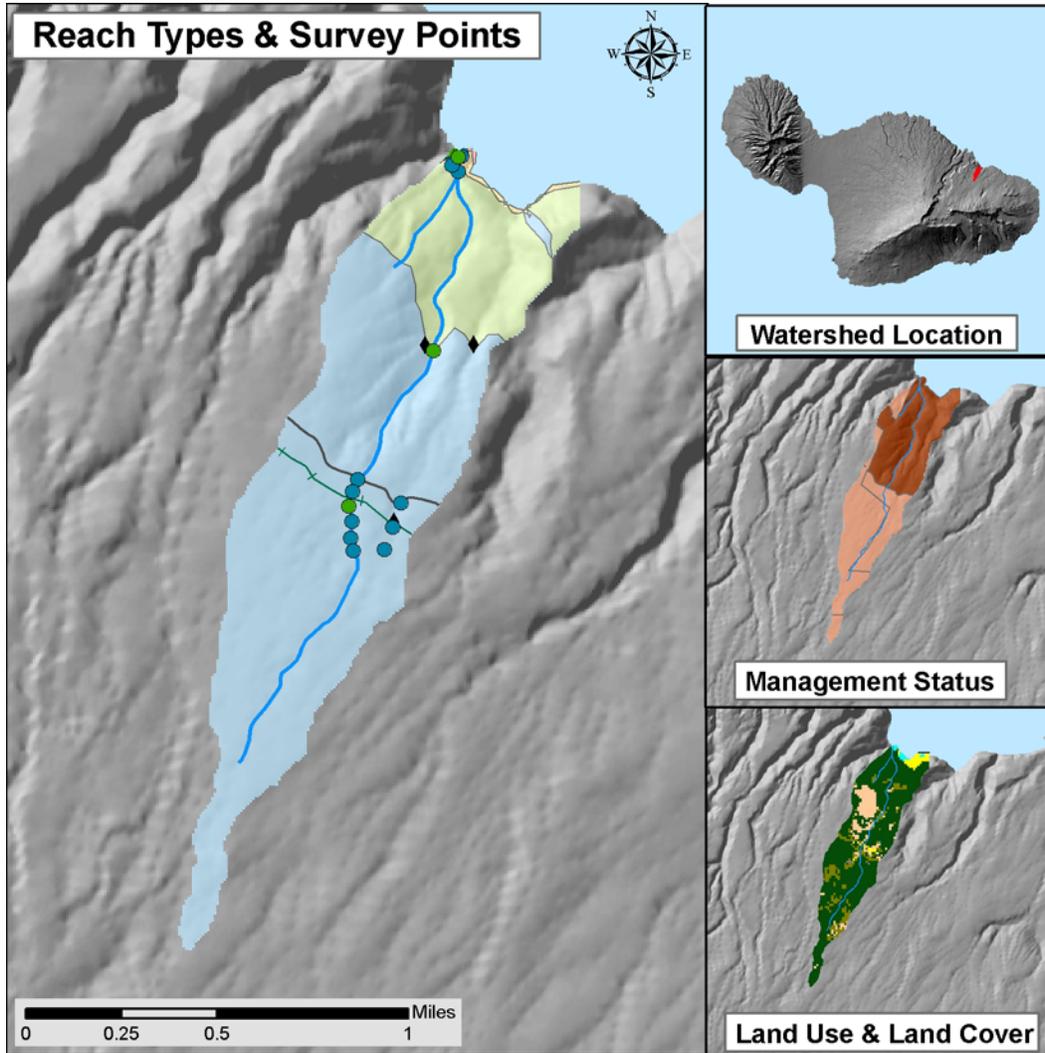
Overall, Pa‘akea Gulch has poor instream habitat for native stream animals due to the reduced stream flow in the upper reach and no flow below the diversion and Hāna Highway, however, the lower reach has very good stream flow which improved the instream habitat for five of the native stream animals. Improvement for fish passage for both up and down stream migration would substantially increase habitat for all the native stream animals but will not enhance the overall productivity of Pa‘akea Gulch significantly.

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Section 2: Watershed Atlas

DAR Watershed Code: 64019

Pa'akea Gulch, Maui



Watershed Features

Pa'akea Gulch watershed occurs on the island of Maui. The Hawaiian meaning of the name is coral bed, limestone. The area of the watershed is 0.7 square mi (1.8 square km), with maximum elevation of 2185 ft (666 m). The watershed's DAR cluster code is 1, meaning that the watershed is small, narrow, and steep, with little embayment. The percent of the watershed in the different land use districts is as follows: 30.4% agricultural, 69.6% 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	0.0	51.3	0.0	0.0	0.0	48.7

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>
0.0	51.3	0.0	48.7

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	0.2	0.00	0.00
Cultivated	0.0	0.00	0.00
Grassland	10.5	0.07	0.19
Scrub/Shrub	11.1	0.08	0.20
Evergreen Forest	74.6	0.52	1.35
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	2.9	0.02	0.05
Unconsolidated Shoreline	0.7	0.01	0.01
Water	0.0	0.00	0.00
Unclassified	0.0	0.00	0.00

Stream Features

Pa'akea Gulch is a perennial stream. Total stream length is 2.1 mi (3.4 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>
0.2	2.1	37.6	60.2	0.0

The following stream(s) occur in the watershed:

Pa'akea

Biotic Sampling Effort

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

1979 2003 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>
DAR Point Quadrat	0	5	2	7	0
DAR Rapid BioAssessment	0	0	0	2	0
Published Report	0	1	1	1	0

Biota Information

Species List

Native Species

Crustaceans *Atyoida bisulcata*

Fish *Awaous guamensis*

Eleotris sandwicensis

Kuhlia xenura

Lentipes concolor

Mugil cephalus

Sicyopterus stimpsoni

Mollusks *Neritina granosa*

Introduced Species

Amphibians *Bufo marinus*

Rana rugosa

Crustaceans *Macrobrachium lar*

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>Bufo marinus</i>	Introduced	2	2	2.0
<i>Atyoida bisulcata</i>	Endemic	0.75	1.5	1.3
<i>Macrobrachium lar</i>	Introduced	2.5	2.5	2.5
<i>Eleotris sandwicensis</i>	Endemic	8	8	8.0
<i>Kuhlia xenura</i>	Endemic	2.5	6	3.8
<i>Lentipes concolor</i>	Endemic	1.25	2.5	1.6
<i>Sicyopterus stimpsoni</i>	Endemic	0.75	2	1.4
<i>Awaous guamensis</i>	Indigenous	2	4	3.0
<i>Mugil cephalus</i>	Indigenous	8	8	8.0
<i>Neritina granosa</i>	Endemic	0.125	0.5	0.3

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				1.35	
<i>Eleotris sandwicensis</i>	Endemic		0.62			
<i>Kuhlia xenura</i>	Endemic		11.6			
<i>Lentipes concolor</i>	Endemic			1.88		
<i>Neritina granosa</i>	Endemic		15.3	46.9		
<i>Awaous guamensis</i>	Indigenous		1.23			
<i>Mugil cephalus</i>	Indigenous		0.62			

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	P	
<i>Eleotris sandwicensis</i>	Endemic		P			
<i>Kuhlia xenura</i>	Endemic		P			
<i>Lentipes concolor</i>	Endemic		P	P		
<i>Sicyopterus stimpsoni</i>	Endemic		P	P		
<i>Neritina granosa</i>	Endemic		P	P		
<i>Awaous guamensis</i>	Indigenous		P	P		
<i>Mugil cephalus</i>	Indigenous		P			
<i>Bufo marinus</i>	Introduced					P
<i>Rana rugosa</i>	Introduced					P
<i>Macrobrachium lar</i>	Introduced		P	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): 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.

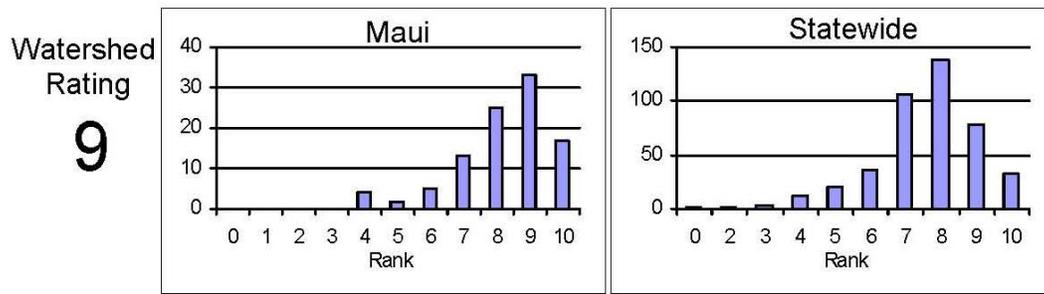
Native Insect Diversity <u>> 19 spp.</u>	Native Macrofauna <u>Diversity > 5 spp.</u>	Absence of Priority 1 <u>Introduced</u>
No	Yes	No
Abundance of Any <u>Native Species</u>	Presence of Candidate <u>Endangered Species</u>	Endangered Newcomb's <u>Snail Habitat</u>
No	No	No

CURRENT WATERSHED AND STREAM RATINGS

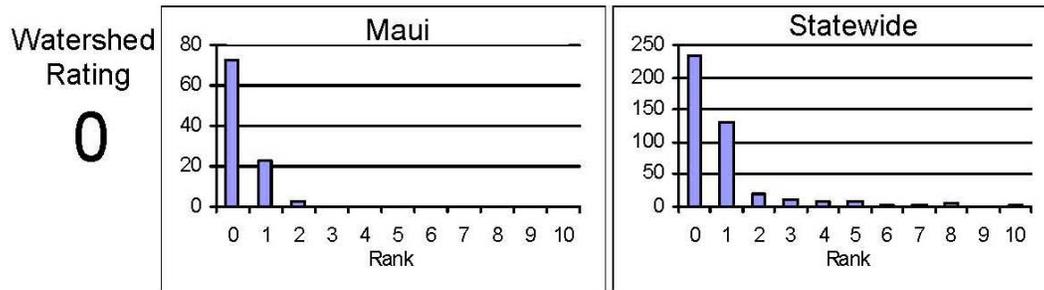
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding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

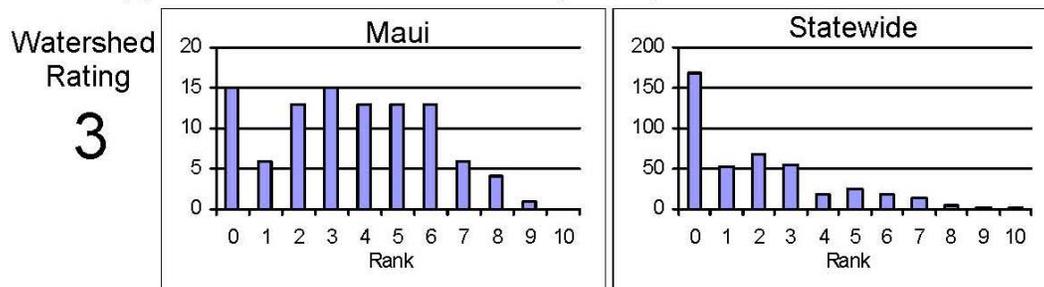
Land Cover Rating: Rating is based on a scoring system where in general forested lands score positively and developed lands score negatively.



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

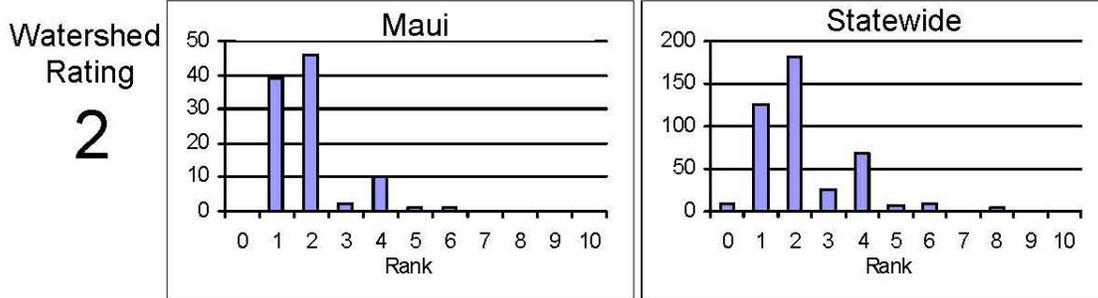


Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.

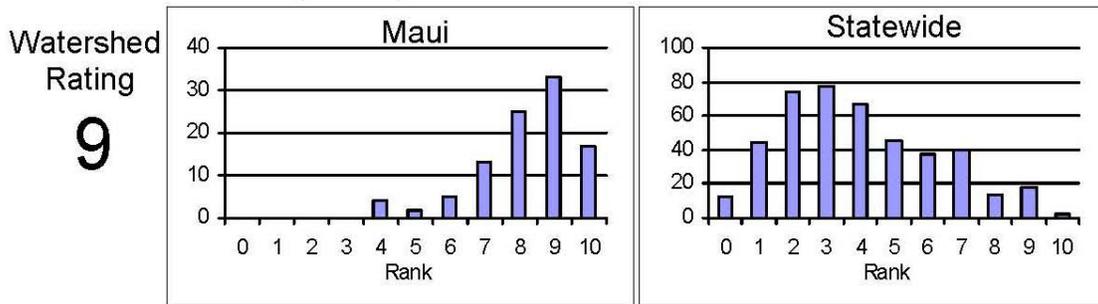


WATERSHED RATING (Cont): Pa'akea Gulch, Maui

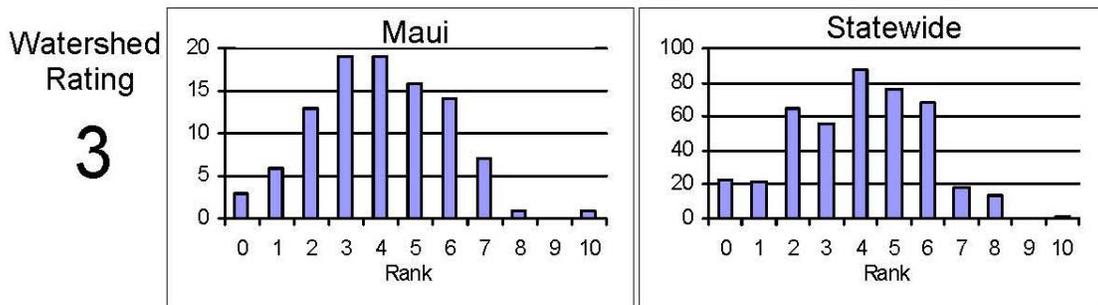
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.



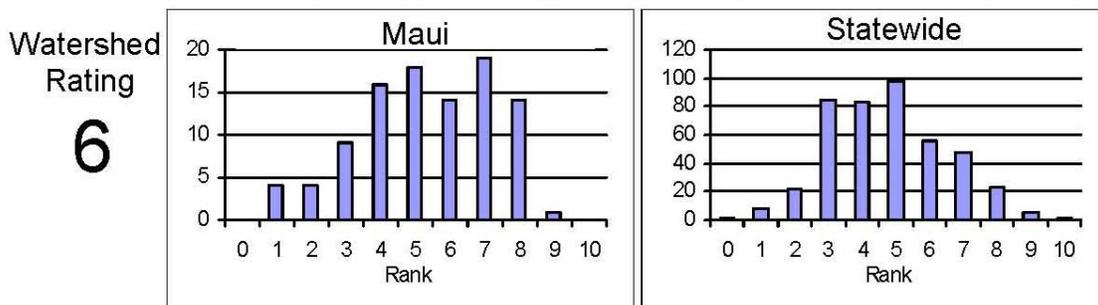
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.



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.



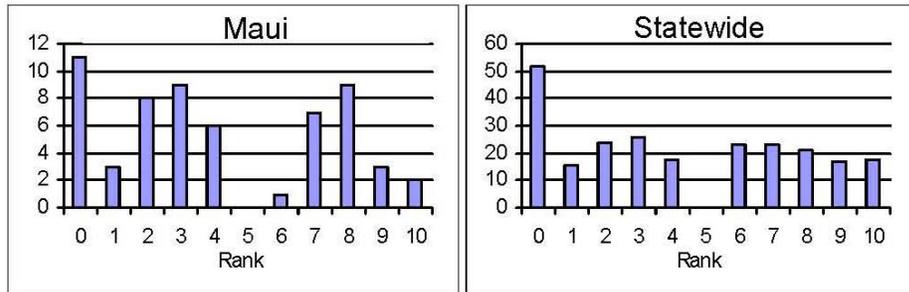
Total Watershed Rating: Rating is based on combination of Land Cover Rating, Shallow Waters Rating, Stewardship Rating, Size Rating, Wetness Rating, and Reach Diversity Rating.



BIOLOGICAL RATING: Pa'akea Gulch, Maui

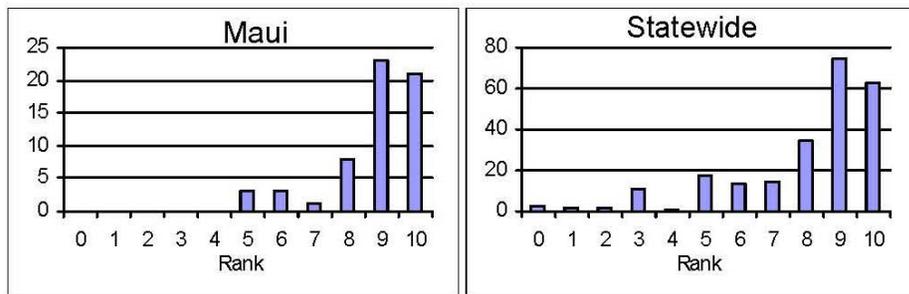
Native Species Rating: Rating is based on the number of native species observed in the watershed.

Stream Rating
8



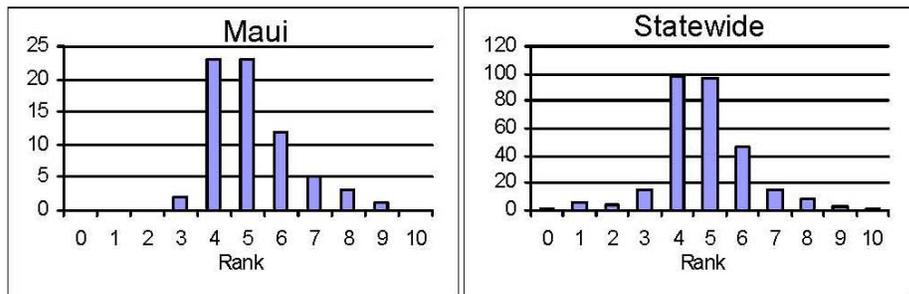
Introduced Genera Rating: Rating is based on the number of introduced genera observed in the watershed.

Stream Rating
8



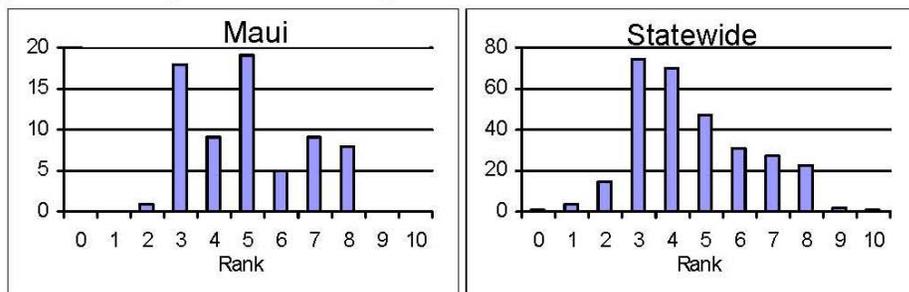
All Species' Score Rating: Rating is based on the Hawaii Stream Assessment scoring system where native species score positively and introduced species score negatively.

Stream Rating
5



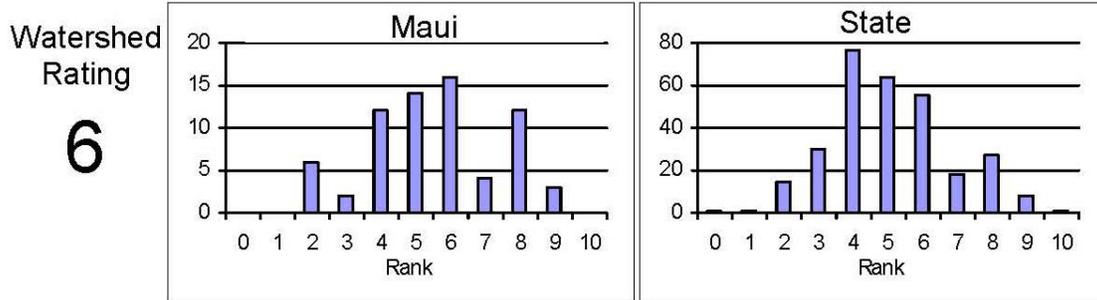
Total Biological Rating: Rating is the combination of the Native Species Rating, Introduced Genera Rating, and the All Species' Score Rating.

Stream Rating
6



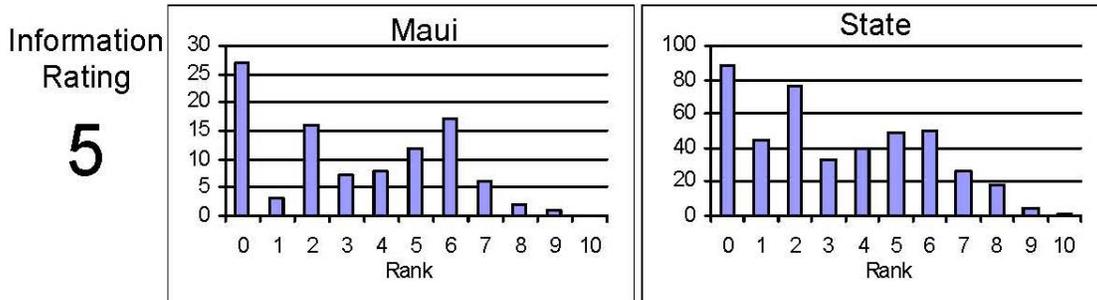
OVERALL RATING: Pa'akea Gulch, Maui

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



RATING STRENGTH: Pa'akea Gulch, 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

1979. Ford, J.I. Biology of a Hawaiian Fluvial Gastropod *Neritina granosa* Sowerby (Prosobranchia: Neritidae). Masters Thesis.

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

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

2008. Hawai'i Division of Aquatic Resources. Rapid Assessment Surveys in DAR Aquatic Surveys Database.

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Section 3: DAR Point Quadrat Report

For Surveys from 2/10/2009 to 5/11/2009

Introduction

This is a report of the Hawai'i 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:

Pa'akea Gulch (ID: 64019), Ke'anae, Maui

Surveys were conducted by these personnel:

Hau, Skippy
Kuamo'o, Darrell
Nishiura, Lance
Shimoda, Troy

Results

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

Reach	Total number of surveys
Estuary	0
Lower	5
Middle	2
Upper	7
Headwaters	0
Unknown	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
Lower	5	1	0	1	3	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
Lower	3	2	0	6	30	59	0

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
Lower	18.728	0.145	8.898	7.87

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

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Fish	Endemic	<i>Sicyopterus stimpsoni</i>
Fish	Indigenous	<i>Mugil cephalus</i>
Fish	Endemic	<i>Lentipes concolor</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 3-6. 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>
Fish	Indigenous	<i>Mugil cephalus</i>	Lower	0.58	1
Fish	Endemic	<i>Kuhlia xenura</i>	Lower	11.03	19
Fish	Endemic	<i>Eleotris sandwicensis</i>	Lower	0.58	1
Fish	Indigenous	<i>Awaous guamensis</i>	Lower	1.16	2
Snails	Endemic	<i>Neritina granosa</i>	Lower	14.52	25

Middle Reach

Table 3-7. 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 3-8. Observed Substrates (%) in point quadrat samples in the middle stream reach.

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Middle	0	0	0	0	0	0	100

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

Reach	Temp (° C)	sCond (mS/cm)	DO (mg/L)	pH
Middle	19.92	0.103	9.44	7.96

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>Lentipes concolor</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>Lentipes concolor</i>	Middle	1.88	1
Snails	Endemic	<i>Neritina granosa</i>	Middle	46.96	25

Upper Reach

Table 3-12. 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	5	0	0	0	0	4	0	1	0	0

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

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Upper	2	0	0	0	4	15	80

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

Reach	Temp (° C)	sCond (mS/cm)	DO (mg/L)	pH
Upper	18.78	0.046	8.178	7.248

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	<i>Rana rugosa</i>
Amphibian	Introduced	<i>Bufo marinus</i>
Crustacean	Endemic	<i>Atyoida bisulcata</i>

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>
Crustaceans	Endemic	<i>Atyoida bisulcata</i>	Upper	0.34	1

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

Reach	Latitude	Longitude	Total CFS	MGD
Lower	20.826205	-156.11508	5.99	3.87
Middle	20.82580	-156.11545	0.87	0.56

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

Latitude	Longitude	Total CFS	MGD
20.81321	-156.11987	0.16	0.1
20.81126	-156.11971	0.16	0.1

Table 3-19. Locations of the diversions found within the upper reach and their corresponding tributary.

Latitude	Longitude	Tributary
20.81321	-156.11987	64019003
20.81315	-156.12061	64019003

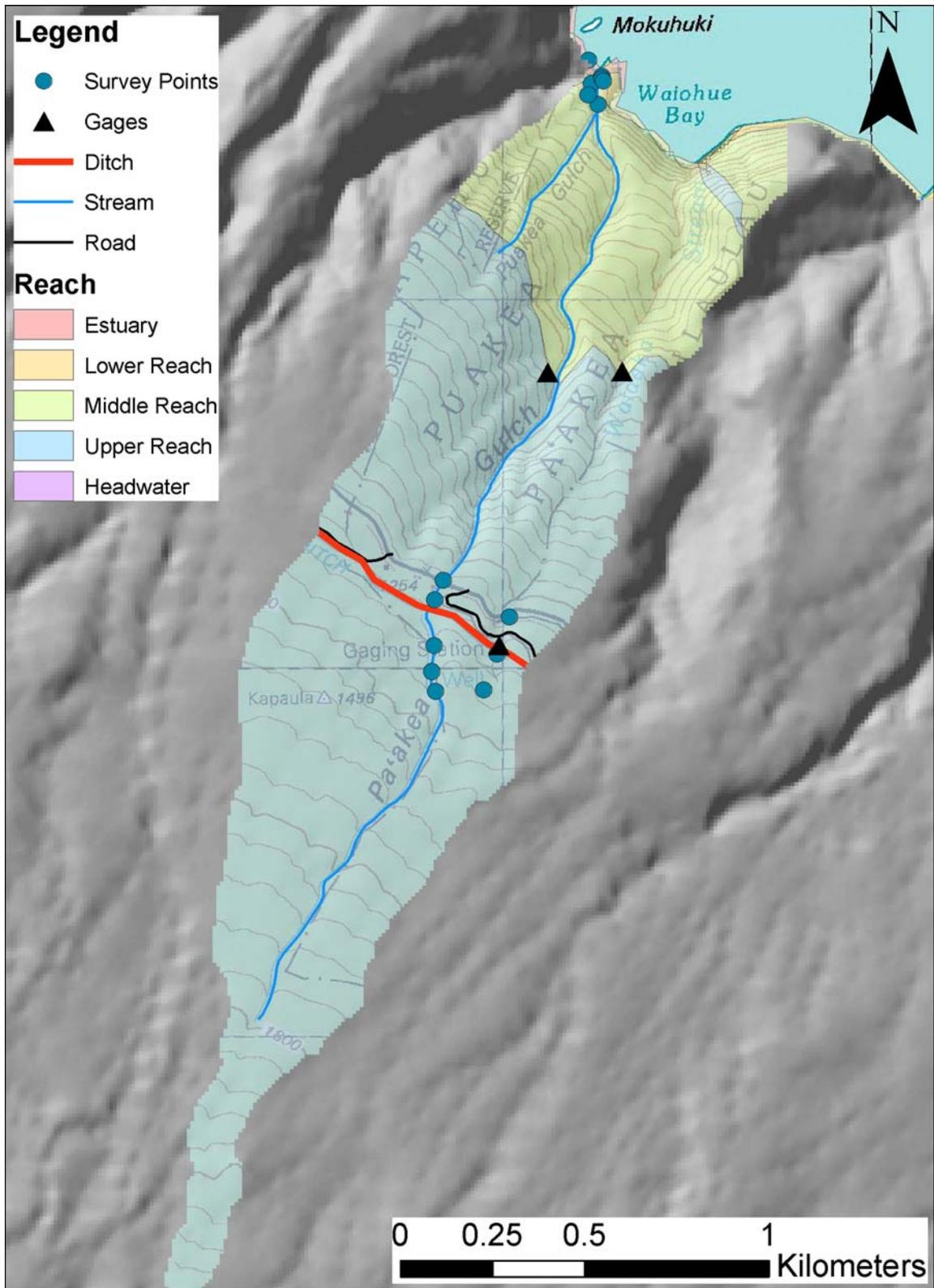


Figure 3-1. Locations of point quadrat surveys conducted in Pa'akea Stream.

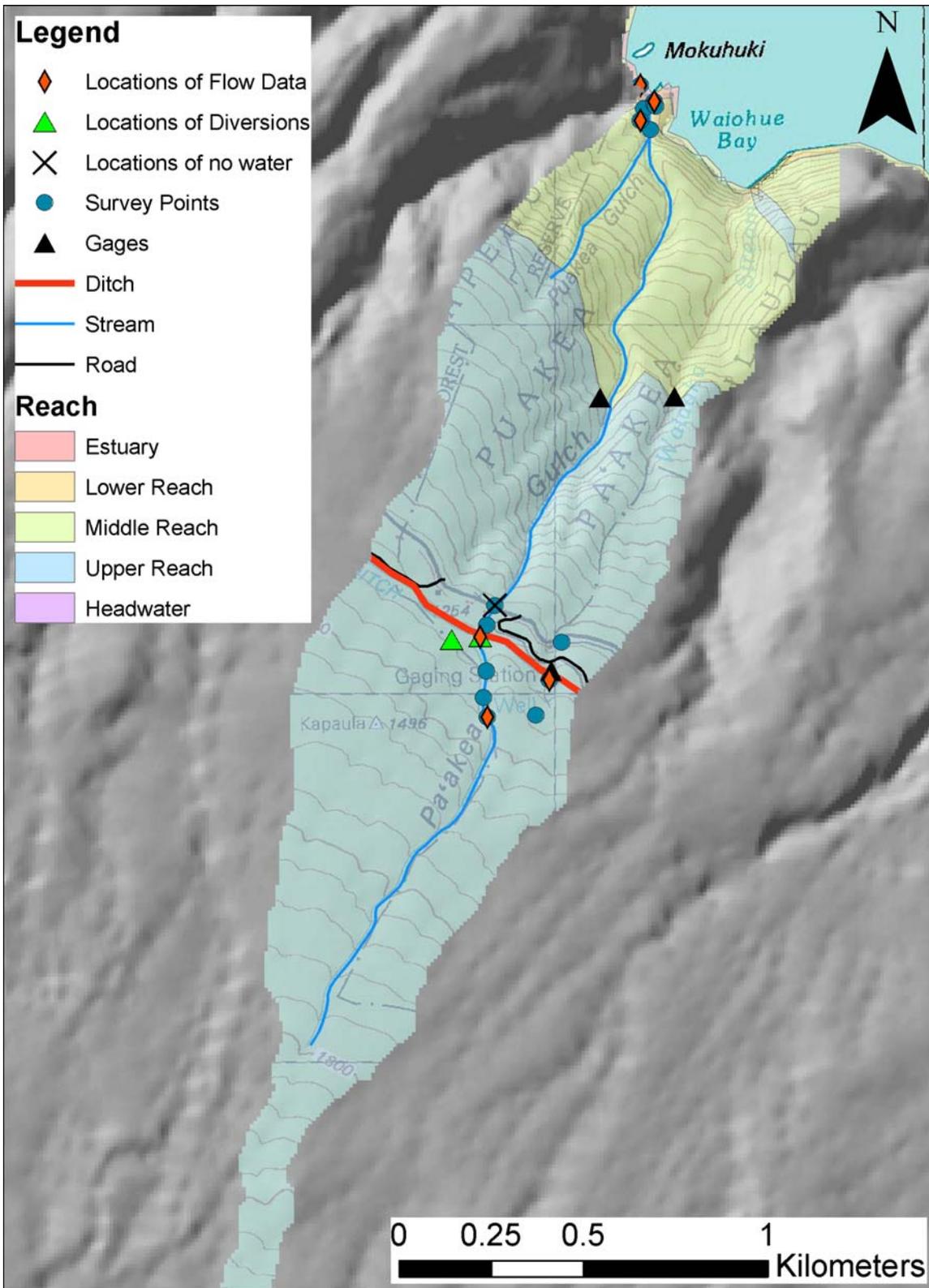


Figure 3-2. Locations of diversion, flow data and no flow surveys conducted in Pa'akea Stream.

Lower and Middle Reach

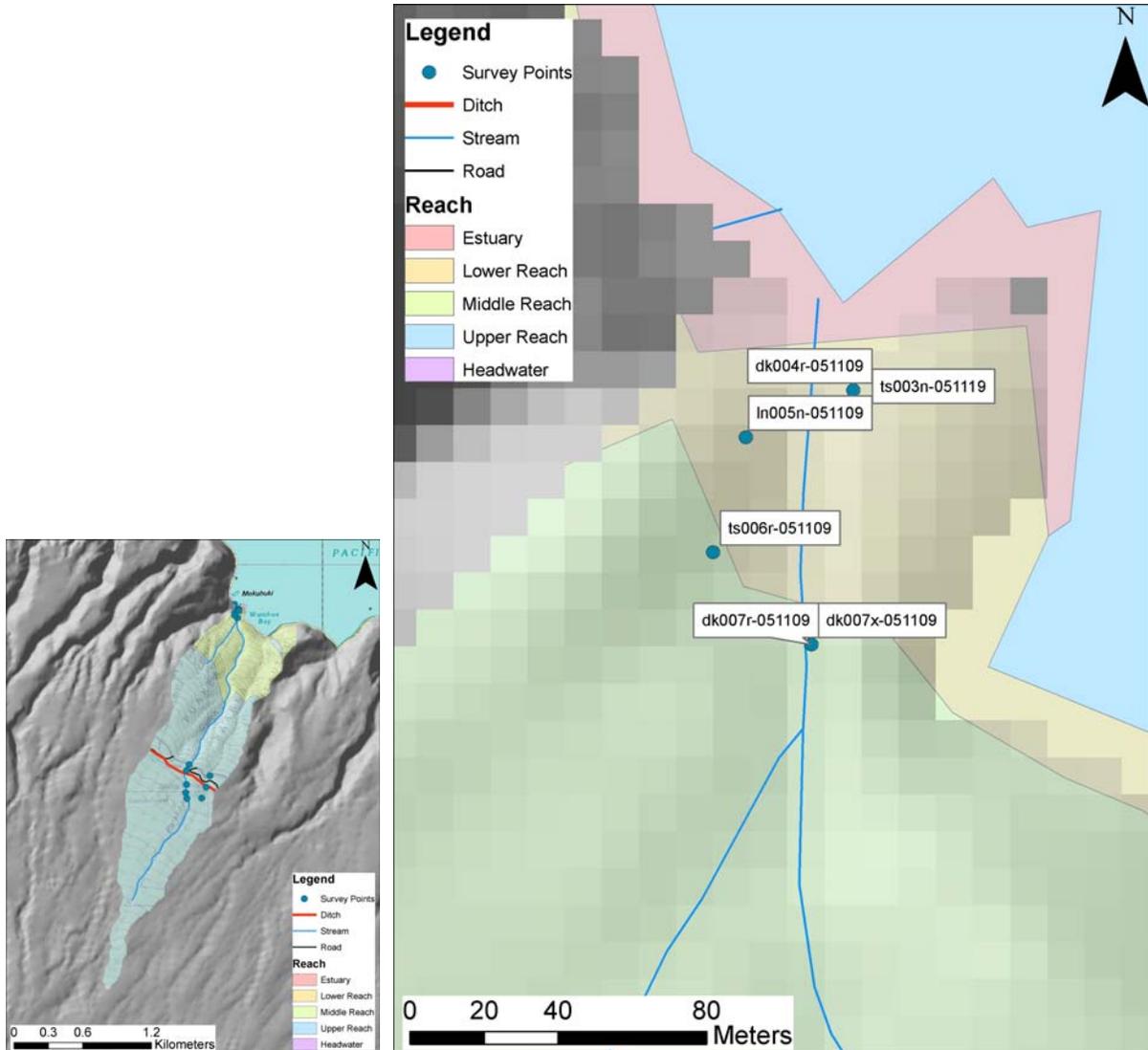


Figure 3-3. Point quadrat survey locations in the lower and middle reaches of Pa'akea Stream.

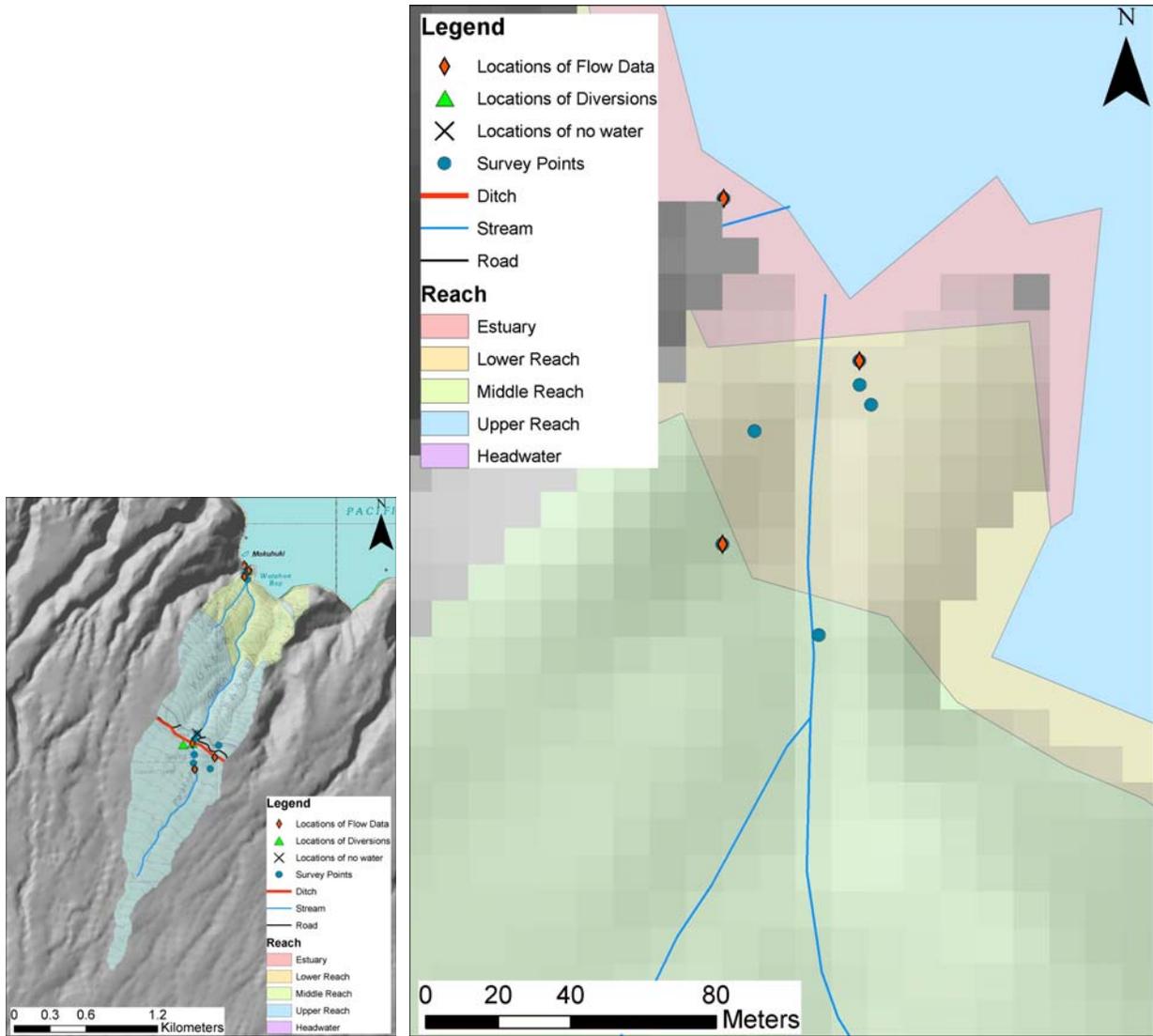


Figure 3-4. Locations of flow measurements taken in the lower and middle reaches of Pa'akea Stream.

Upper Reach

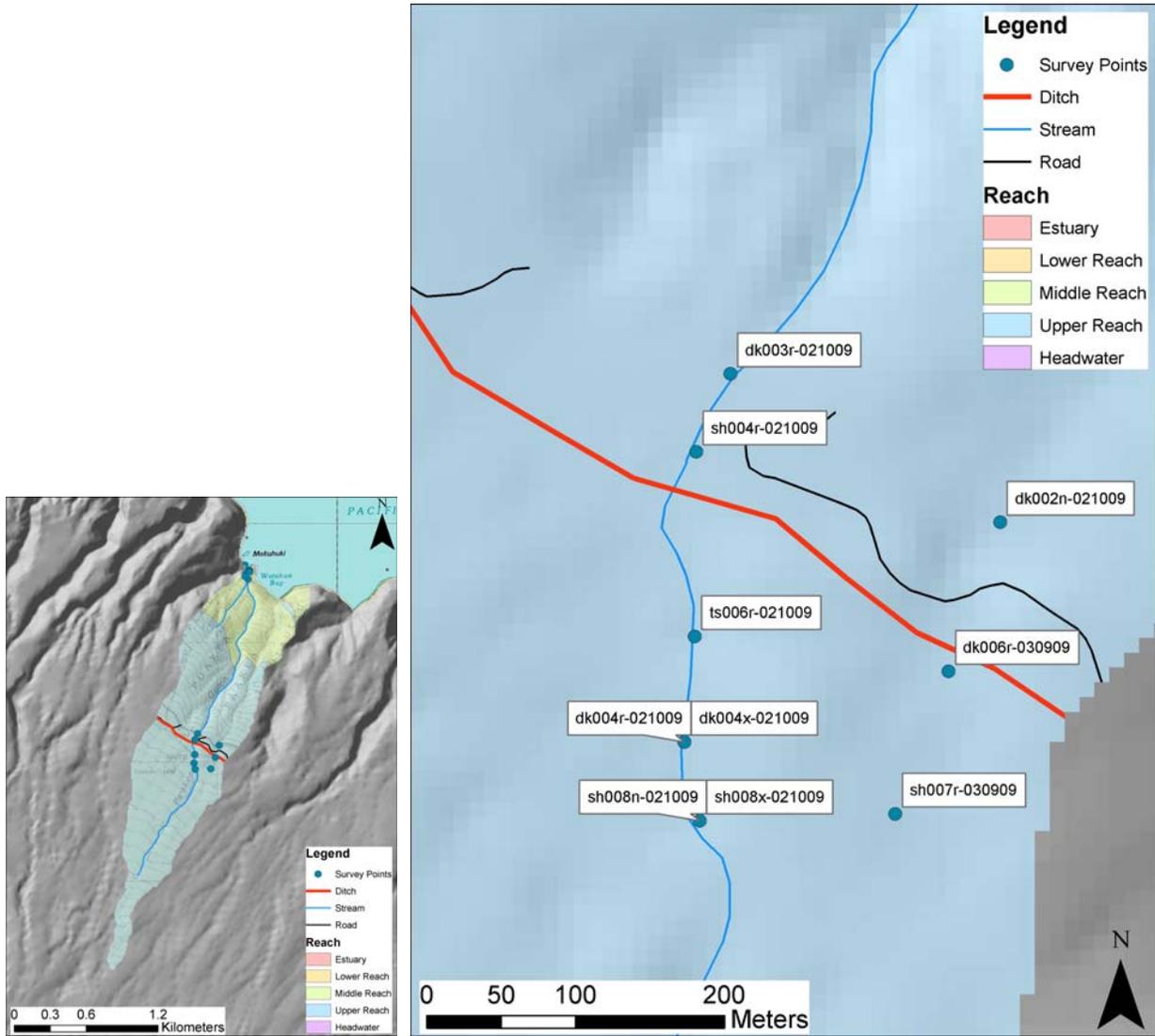


Figure 3-5. Point quadrat survey locations in the upper reach of Pa'akea Stream.

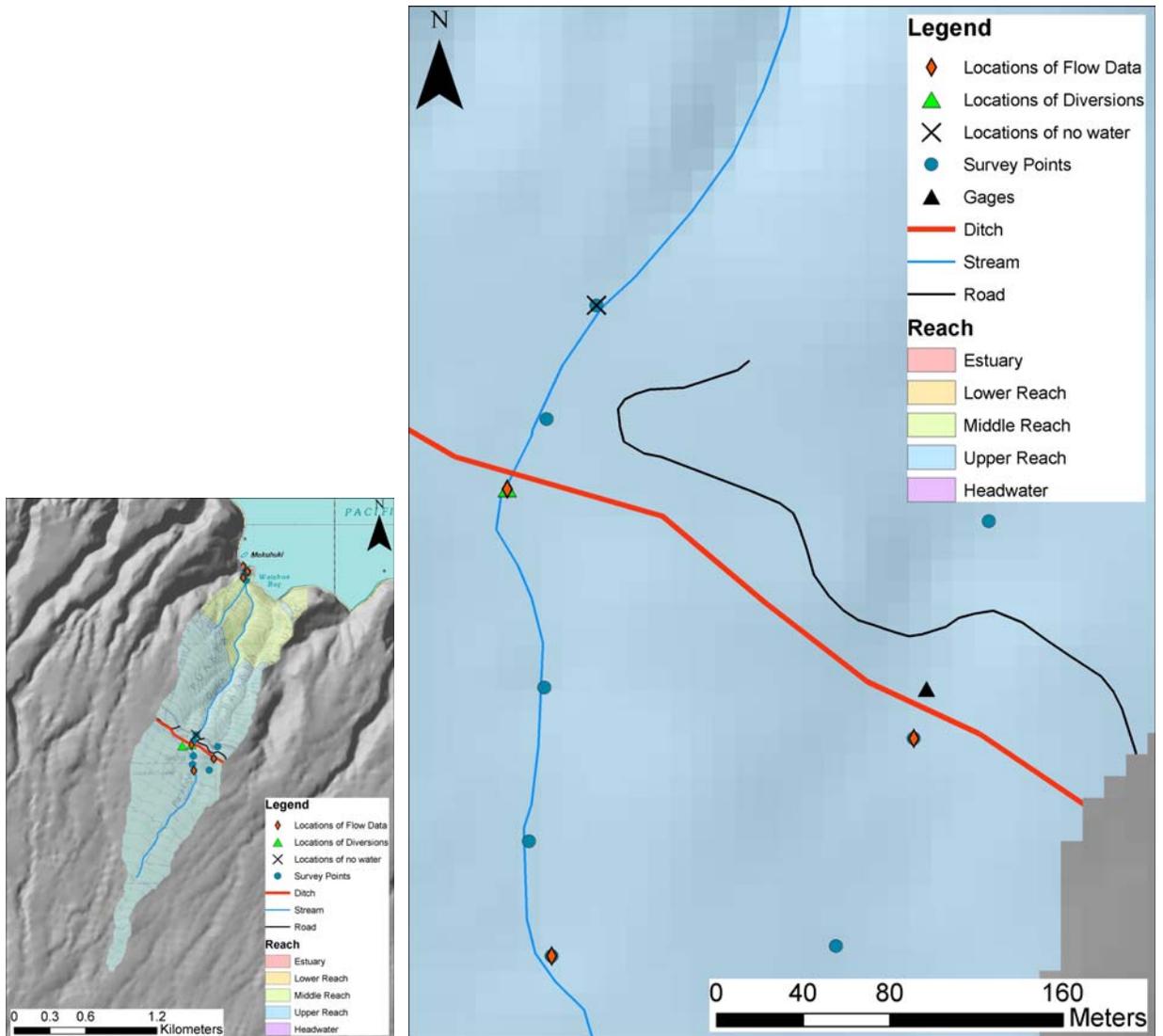


Figure 3-6. Locations of diversions and flow measurements taken in the upper reach of Pa'akea Stream.

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Section 4: DAR Estuary Survey Report Conducted in Pa'akea, Maui

For Surveys Conducted on: 5/11/2009

Introduction

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

Pa'akea (ID: 64019), Ke'anae, Maui

Surveys were completed by these DAR staff:

Kuamo'o, Darrell

Nishiura, Lance

Shimoda, Troy

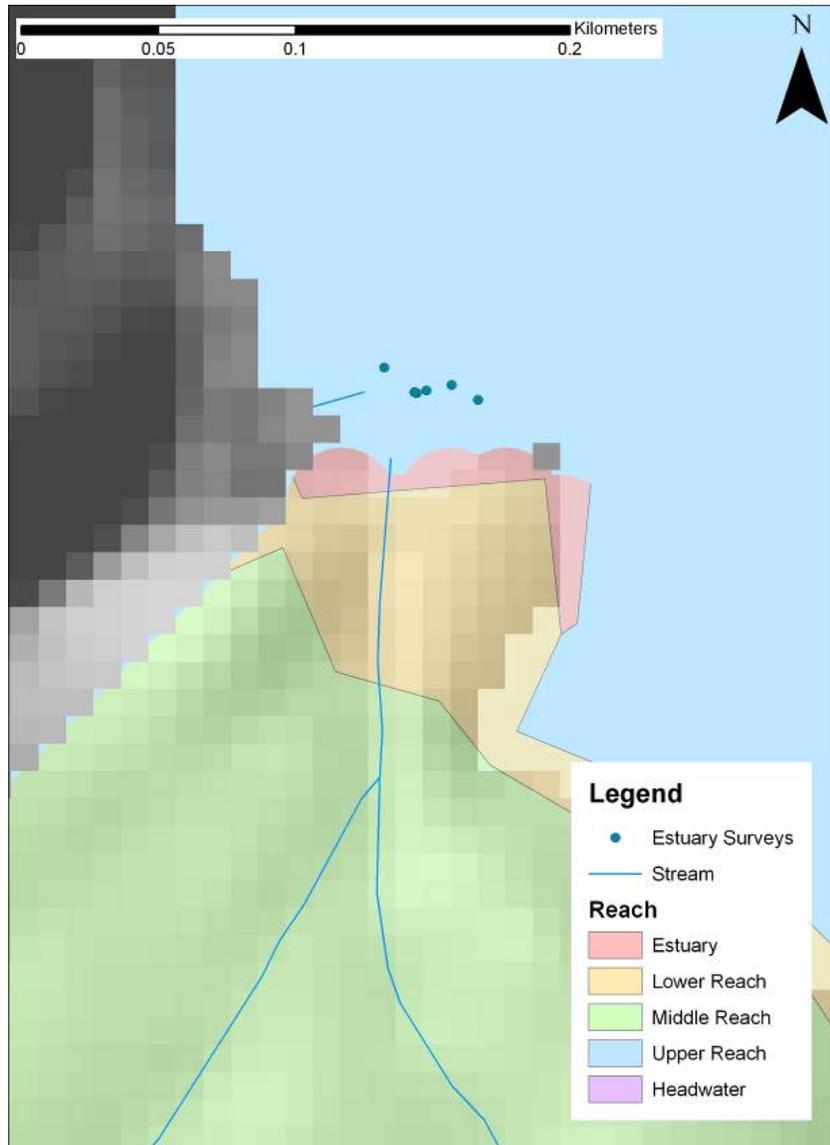


Figure 4-1. Location of estuary surveys conducted in Pa'akea.

Results

Table 4-1. Summary of estuary classification and habitat description in Pa'akea.

Location	Location ID	Estuary Status	Estuary Type	Reach	Habitat Type(s)
Pa'akea	18	Natural	Coastal Embayment	Lower	Boulder

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

Avg Detritus	Avg Sediment	Avg Sand	Avg Gravel	Avg Cobble
0	0	0	4	12
Avg Boulder	Avg Bedrock	Avg Emergent Veg	Avg Submergent Veg	Avg Coral
84	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 Pa'akea.

Location	Location ID	Depth min (cm)	Depth max (cm)	Depth avg (cm)	Depth Std dev. (cm)
Pa'akea	18	36	73	52	16.56

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

Location	Location ID	DO min (mg/L)	DO max (mg/L)	DO avg. (mg/L)	DO Std. Dev. (mg/L)
Pa'akea	18	5.08	8.10	6.45	1.18

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

Location	Location ID	pH min	pH max	pH avg.	pH Std. Dev.
Pa'akea	18	7.84	8.10	7.94	0.08

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

Location	Location ID	Salinity min (ppt)	Salinity max (ppt)	Salinity avg. (ppt)	Salinity Std. Dev. (ppt)
Pa'akea	18	9.24	19.04	13.53	4.70

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

Location	Location ID	Temp min (° C)	Temp max (° C)	Temp avg. (° C)	Temp Std. Dev. (° C)
Pa‘akea	18	20.10	22.23	21.09	0.99

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

Location	Location ID	Number of Surveys	Species	Category	Status	# of animals
Pa‘akea	18	6	<i>Atherinomorus insularum</i>	Fish	Endemic	1
			<i>Kuhlia xenura</i>	Fish	Endemic	6
			<i>Thalassoma trilobatum</i>	Fish	Indigenous	1

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>Atherinomorus insularum</i>	Fish	1	48	48	48	
<i>Kuhlia xenura</i>	Fish	6	80	31	49	18.08
<i>Thalassoma trilobatum</i>	Fish	1	182	182	182	

Summary

Estuary Surveys were conducted in the estuary reach of Pa‘akea. A total of 42 m of shoreline was surveyed in 1 discrete section. Physical characteristics of Pa‘akea estuary consisted of boulder terrain and moderate surf with white water in a small cove. The mouth of Pa‘akea stream was closed by a boulder/cobble berm created by high surf and low flow from the stream. Two common estuarine species, *Atherinomorus insularum* and (*Kuhlia xenura*), and one marine species, *Thalassoma trilobatum*, were recorded, reflecting the habitat conditions during the time of the survey.

Species observed in Pa‘akea Estuary:

Native Species

Fish *Atherinomorus insularum*,
 Kuhlia xenura,
 Thalassoma trilobatum,

Section 5: Photographs taken during stream surveys

Estuary and Lower Reach

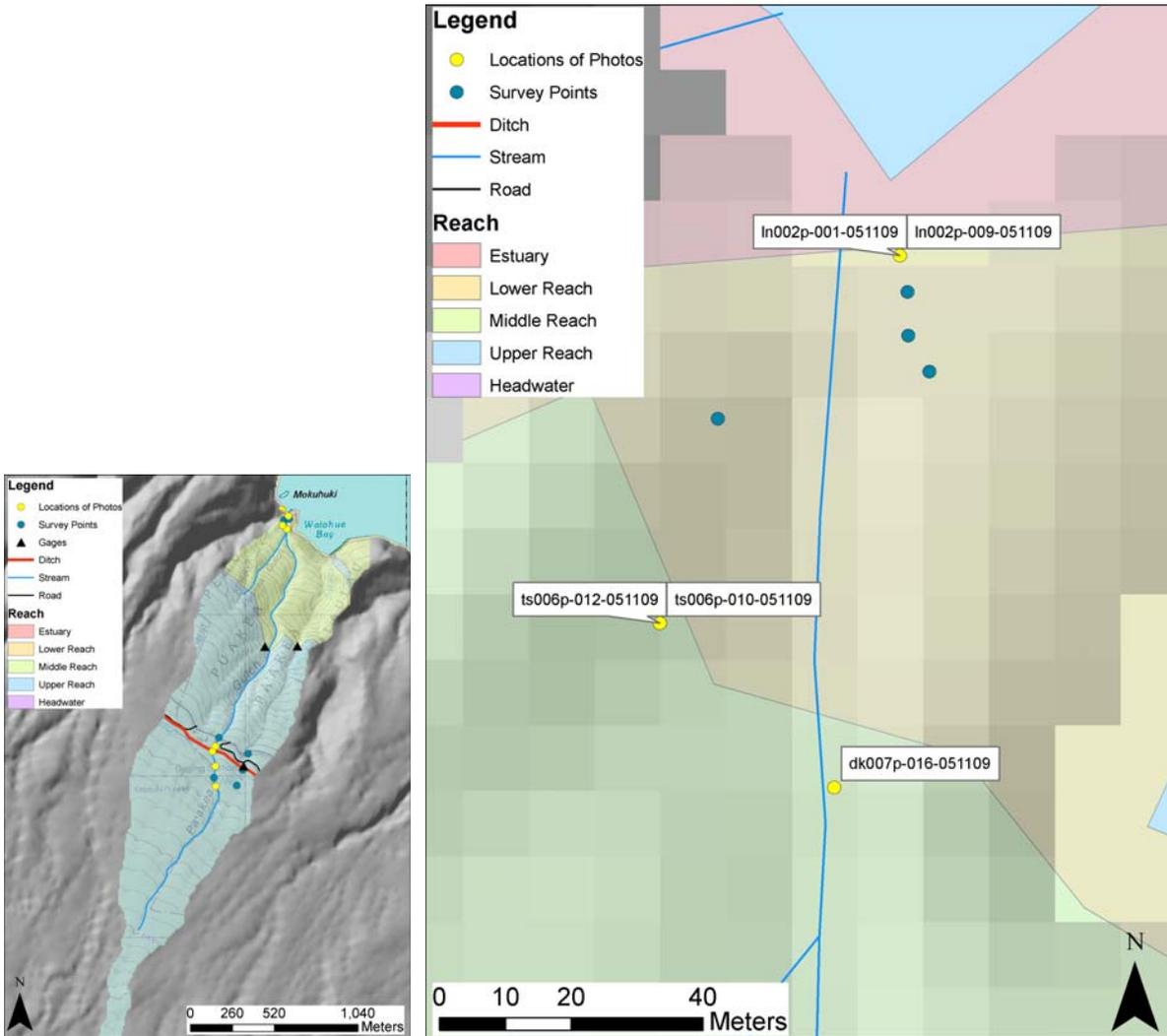


Figure 5-1. Photo locations in the estuary, lower, and middle reaches of Pa'akea Stream.



Figure 5-2. Beach between Pa'akea and Waiohue streams. Note first waterfall (circled); (4/8/2009; Tributary name: Pa'akea (64019001); PBN: dk64019001p-003-040809; Photo by: Kuamo'o, D.).



Figure 5-3. Boulder beach at the mouth of Pa'akea Gulch. Photo oriented eastward. (5/11/2009; Tributary name: Pa'akea (64019001); PBN: ln002p-001-051109; Lat. (DD): 20.82630, Long. (DD): -156.11509).



Figure 5-4. Christmas wrasse (*Thalassoma trilobatum*), common in rocky habitats with high surge. (5/11/2009; Tributary name: Pa'akea (64019001); PBN: In002p-009-051109; Lat. (DD): 20.82630, Long. (DD): -156.11509).



Figure 5-5. First waterfall on Pa'akea stream. (4/8/2009; Tributary name: Pa'akea (64019001); PBN: dk64019001p-002-040809; Photo by: Kuamo'o, D.).



Figure 5-6. DAR stream surveyors conducting flow measurements at site 6. Photo taken downstream of site 6. (5/11/2009; Tributary name: Pa'akea (64019002), PBN: ts006p-012-051109; SBN: 110; Lat. (DD): 20.82580, Long. (DD): -156.11545).

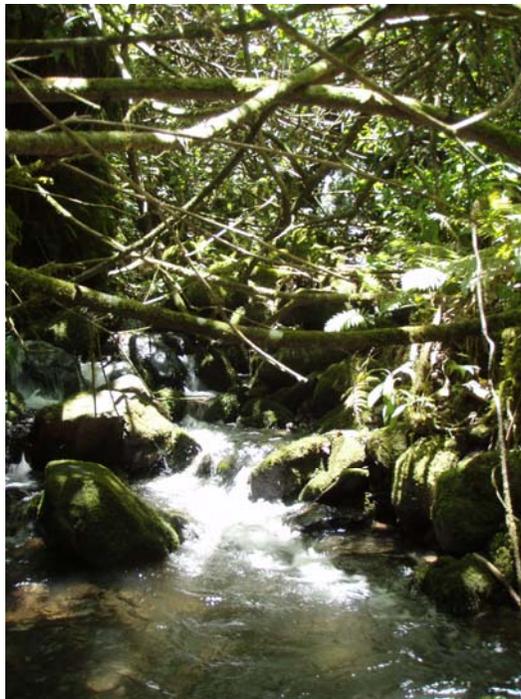


Figure 5-7. View of survey site 6 with thick vegetation. Photo taken upstream of site 6. (5/11/2009; Tributary name: Pa'akea (64019002); PBN: ts006p-010-051109; Surveyor: Shimoda, T.; Habitat type: Riffle; SBN: ts006r-051109; Lat. (DD): 20.82580, Long. (DD): -156.11545).

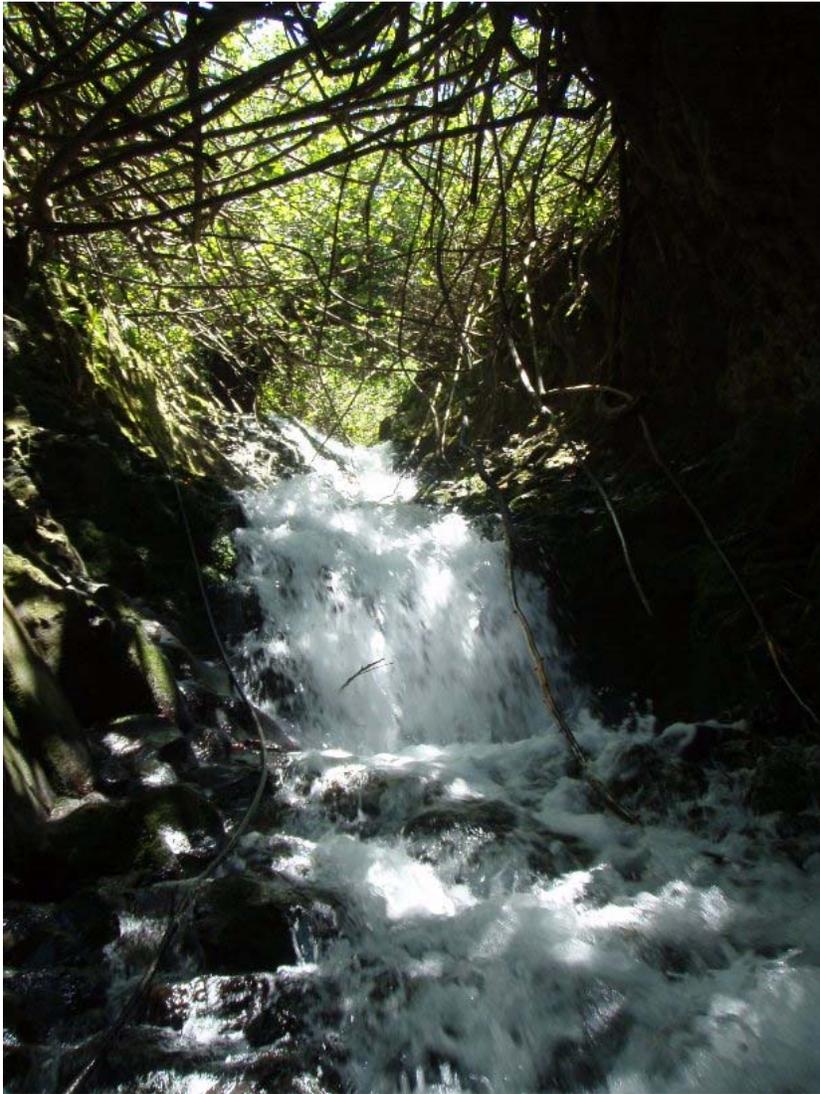


Figure 5-8. Cascading waterfall in middle reach at survey site 7 of Pa'akea Stream. (5/11/2009; Tributary name: Pa'akea (64019003); PBN: dk007p-016-051109; Surveyor: Kuamo'o, D.; Habitat type: Plunge Pool; SBN: dk007r-051109; Lat. (DD): 20.82557, Long. (DD): -156.1152).

Upper Reach

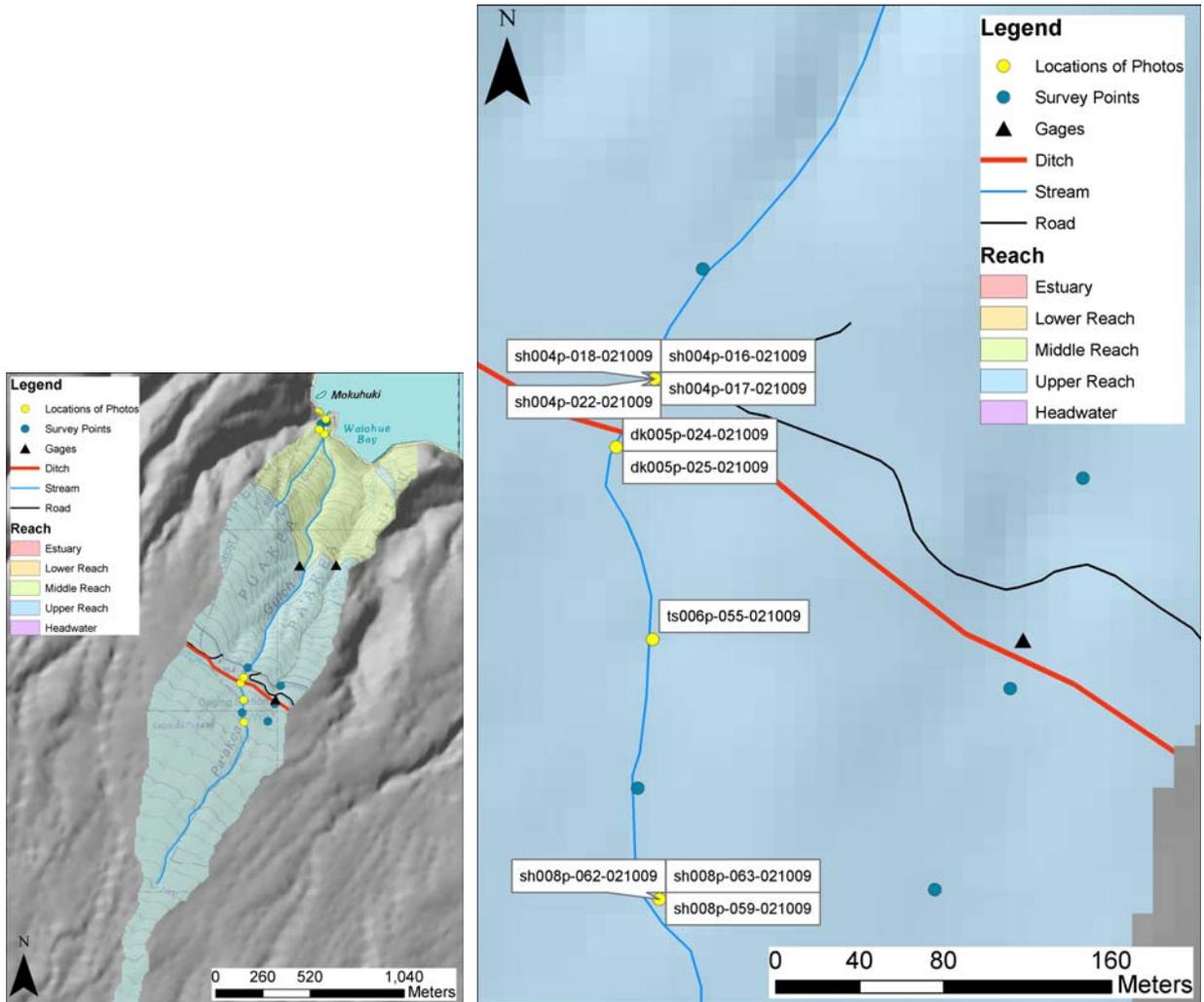


Figure 5-9. Photo locations in the upper reach of Pa'akea Stream.



Figure 5-10. Photo of survey site 4. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: sh004p-016-021009; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh004r-021009; Lat. (DD): 20.81350, Long. (DD): -156.11969).



Figure 5-11. Photo upstream of survey site 4. The circle shows a diversion above the survey site. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: sh004p-017-021009; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh004r-021009; Lat. (DD): 20.81350, Long. (DD): -156.11969).



Figure 5-12. Photo taken downstream of survey site 4. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: sh004p-018-021009; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh004r-021009; Lat. (DD): 20.81350, Long. (DD): -156.11969).



Figure 5-13. Photo of the diversion above survey site 4. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: sh004p-022-021009; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh004r-021009; Lat. (DD): 20.81350, Long. (DD): -156.11969).



Figure 5-14. Photo shows the continuation of the wall and the ditch where the stream is diverted to. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: dk005p-025-021009; Surveyor: Kuamo'o, D.; SBN: dk005d-021009; Lat. (DD): 20.81321, Long. (DD): -156.11987).



Figure 5-15. Photo shows a wall that diverts the water from the stream. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: dk005p-024-021009; Surveyor: Kuamo'o, D.; SBN: dk005d-021009; Lat. (DD): 20.81321, Long. (DD): -156.11987).

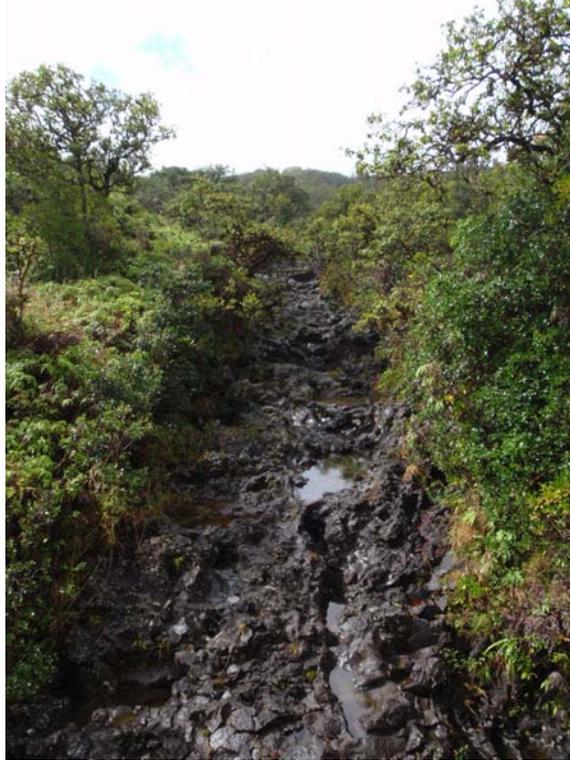


Figure 5-16. Photo taken downstream of the diversion. Note there is no flowing water. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: dk005p-037-021009; Surveyor: Kuamo'o, D.; SBN: dk005d-021009; Lat. (DD): 20.81321, Long. (DD): -156.11987).

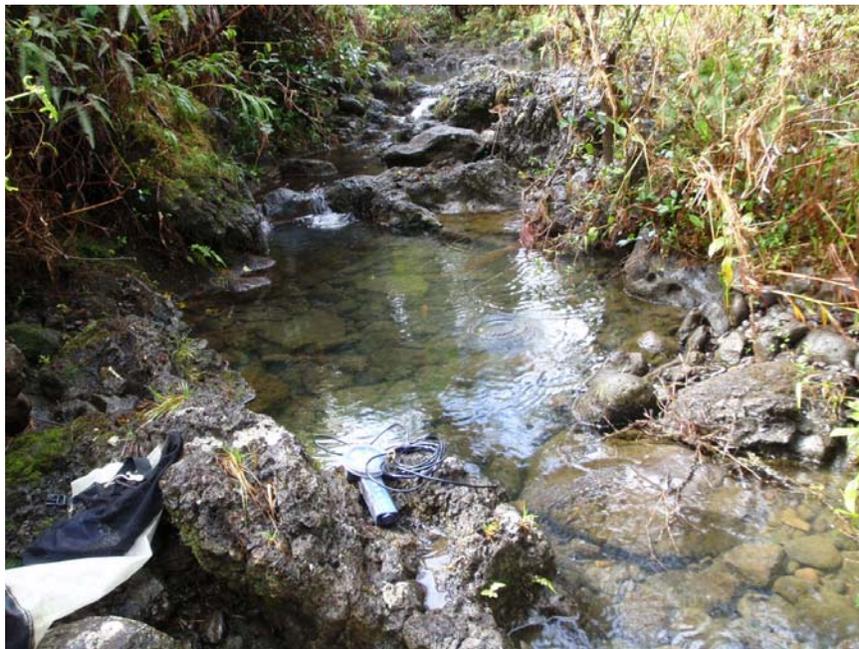


Figure 5-17. Photo shows survey site 6 and is taken in an upstream direction. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: ts006p-055-021009; Surveyor: Shimoda, T.; Habitat type: Pool; SBN: ts006r-021009; Lat. (DD): 20.81238, Long. (DD): -156.11972).



Figure 5-18. Photo of DAR staff taking water flow measurements in Pa'akea Gulch. . Photo taken downstream from site 8. (2/10/2009; Tributary name: (64019003); PBN: sh008p-062-021009; Surveyor: Hau, S.; SBN: 83; Lat. (DD): 20.81126, Long. (DD): -156.11971).



Figure 5-19. Photo shows the upstream area of survey site 8 and where the flow was measured. (2/10/2009; Tributary name: (64019003); PBN: sh008p-063-021009; Surveyor: Hau, S.; SBN: 83; Lat. (DD): 20.81126, Long. (DD): -156.11971).



Figure 5-20. Plunge pool in Pa'akea Gulch. Photo taken upstream from site 8. (2/10/2009; Tributary name: Pa'akea (64019003); PBN: sh008p-059-021009; Surveyor: Hau, S.; SBN: sh008n-021009; Lat. (DD): 20.81126, Long. (DD): -156.11971).

References

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

Hawai'i Division of Aquatic Resources. 2008. Rapid Assessment Surveys in DAR Aquatic Surveys Database.

Juvik, S.P. and J.O. Juvik. 1998. Atlas of Hawai'i. University of Hawaii Press

Pukui, M.K. and S.H. Elbert. 1971. Hawaiian Dictionary. University of Hawaii Press.

Pukui, M.K., S.H. Elbert and E.T. Mookini. 1976. Place Names of Hawaii. University of Hawaii Press.

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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>
64019001	Pa'akea	dk001r-051109	1	Kuamo'o, Darrell	5/11/2009		
64019001	Pa'akea	ln002n-051109	2	Nishiura, Lance	5/11/2009	20.82625	-156.11508
64019002	Pa'akea	dk004r-051109	4	Kuamo'o, Darrell	5/11/2009	20.82619	-156.11508
64019002	Pa'akea	ln005n-051109	5	Nishiura, Lance	5/11/2009	20.82608	-156.11536
64019002	Pa'akea	ts006r-051109	6	Shimoda, Troy	5/11/2009	20.82580	-156.11545
64019003	Pa'akea	dk003r-021009	3	Kuamo'o, Darrell	2/10/2009	20.81397	-156.11946
64019003	Pa'akea	sh004r-021009	4	Hau, Skippy	2/10/2009	20.81350	-156.11969
64019003	Pa'akea	dk004x-021009	4	Kuamo'o, Darrell	2/10/2009	20.81174	-156.11980
64019003	Pa'akea	dk004r-021009	4	Kuamo'o, Darrell	2/10/2009	20.81174	-156.11980
64019003	Pa'akea	ts006r-021009	6	Shimoda, Troy	2/10/2009	20.81238	-156.11972
64019003	Pa'akea	sh008x-021009	8	Hau, Skippy	2/10/2009	20.81126	-156.11971
64019003	Pa'akea	sh008n-021009	8	Hau, Skippy	2/10/2009	20.81126	-156.11971
64019003	Pa'akea	dk007x-051109		Kuamo'o, Darrell	5/11/2009	20.82557	-156.11520
64019003	Pa'akea	ts003n-051119	3	Shimoda, Troy	5/11/2009	20.82614	-156.11505
64019003	Pa'akea	dk007r-051109	7	Kuamo'o, Darrell	5/11/2009	20.82557	-156.11520

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