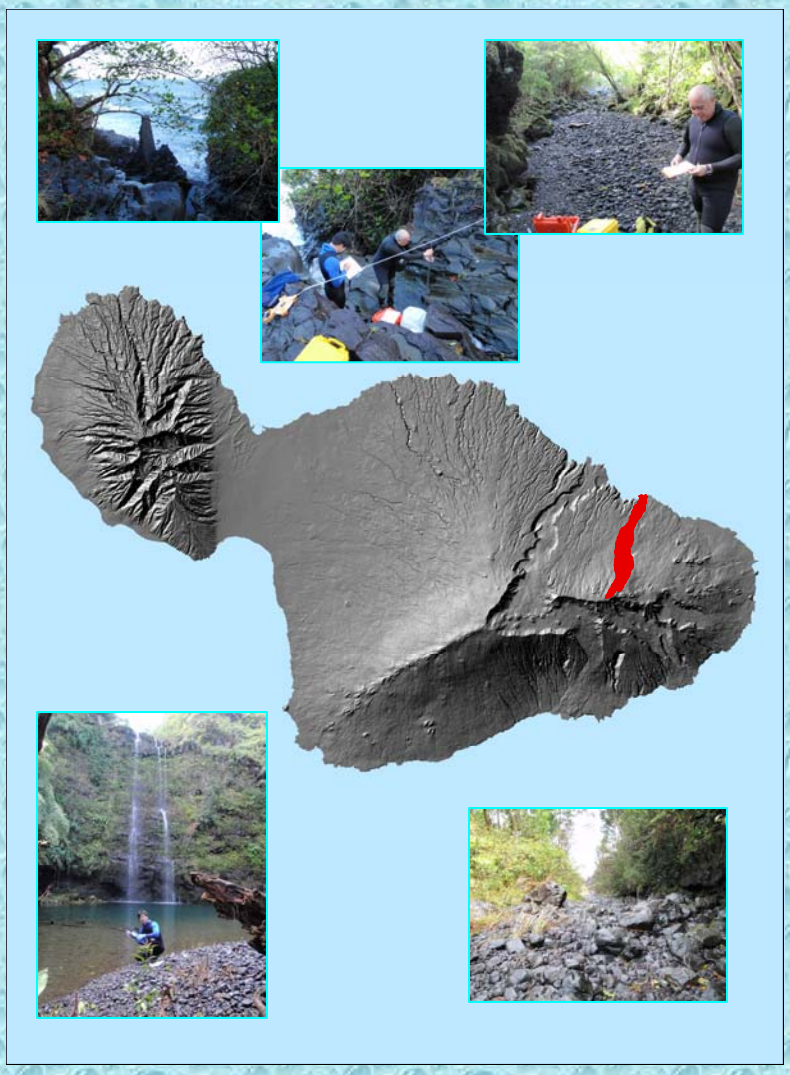
Report on Makapipi Stream
Maui, Hawaii



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.

Report on Makapipi Stream Maui, Hawai‘i

August 2009

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

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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 Makapipi 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 four main sections, including:

- Introduction
- Watershed Atlas Report
- DAR Point Quadrat 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. 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 Makapipi Stream while also providing substantial evidence to support the conclusions presented.

Findings for Makapipi Stream, Maui

Makapipi is a small (5.3 sq miles). It is mostly zoned for conservation (85%) and agriculture (15%) and the land cover is mostly evergreen forest (87%), scrub (8%), grassland (4%) and bare land (1%). Numerous stream surveys of different types have been completed in Makapipi

Stream beginning in 1962 to the present. This watershed rates high, based on the data contained in the DAR aquatic surveys database, in comparison to other watersheds in Maui and statewide. It has a total watershed rating of 8 out of 10, a total biological rating of 6 out of 10, and a combined overall rating of 8 out of 10.

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

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

Crustaceans - *Atyoida bisulcata*

Worms - Hirudinean sp.

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

Amphibian – *Bufo marinus, Rana rugosa* and Ranid sp.

Crustaceans - *Macrobrachium lar* and *Procambarus clarkii*

Mollusks - Lymnaeid sp. and *Lymnea sp.*

Reptiles - *Chrysemys sp.*

Photographs were taken of interesting features of stream habitat and diversions. Photographs show that dry sections exist downstream of diversions.

Discussion

Makapipi watershed is small, steep in the upper reach with no embayment or estuary at the stream mouth. The stream flows directly to the ocean through a cobble beach from a small waterfall (Figures 4-2 & 4-3). Flow at the waterfall was just a trickle at the time of the point quadrat survey. The substrate in the lower reach of Makapipi Stream is characterized by bedrock as seen in the first couple of survey sites (Figures 4-4 to 4-6). The middle reach substrate was characterized by cobble, boulder and bedrock with sites of dry streambed. In the middle reach pools barely connected by flow suggesting highly diverted stream. Isolated pools did have water and the water temperature was 18.9° C, probably due to springs in the reach. The upper reach substrate was characterized by half bedrock and quarter cobble and boulders. The water temperature was 20.8° C, warmer than the middle reach. The waterfalls in the upper reach had minimal flow as evidenced in the photographs (Figure 4-12).

A helicopter was used to access the different reaches of Makapipi Stream during the surveys of the reaches because of watersheds steepness and inaccessibility by foot. There are no roads to access stream below and above Hāna highway. The lower, middle, and upper reaches were survey by helicopter access. The upper reach just above and below the Hāna Highway were accessed from the highway.

No estuary surveys were conducted on Makapipi Stream due to a small terminal waterfall.

Point quadat surveys conducted in the lower reach did not provide any native animal observations. The native goby, **ʻoʻopu alamoʻo** (*Lentipes concolor*) was observed in the middle and upper reaches. The native shrimp, **ʻōpae kalaʻole** (*Atyoida bisulcata)*, was only observed in the upper reaches.

Small pools isolated by dry streambed sections and dry waterfalls are indicative of a stream that

has been highly diverted. Survey sites with no water are shown in Figures 3-2 & 3-3 and are distributed throughout the middle and upper reaches below the diversion. Above the diversion (Figures 4-21 & 4-23) which captured 100 percent of the flow, the native shrimp, *A. bisulcata* was observed and the flow measurements were from 1.47 to 1.75 cfs (Figures 4-22; 4-23 to 4-25).

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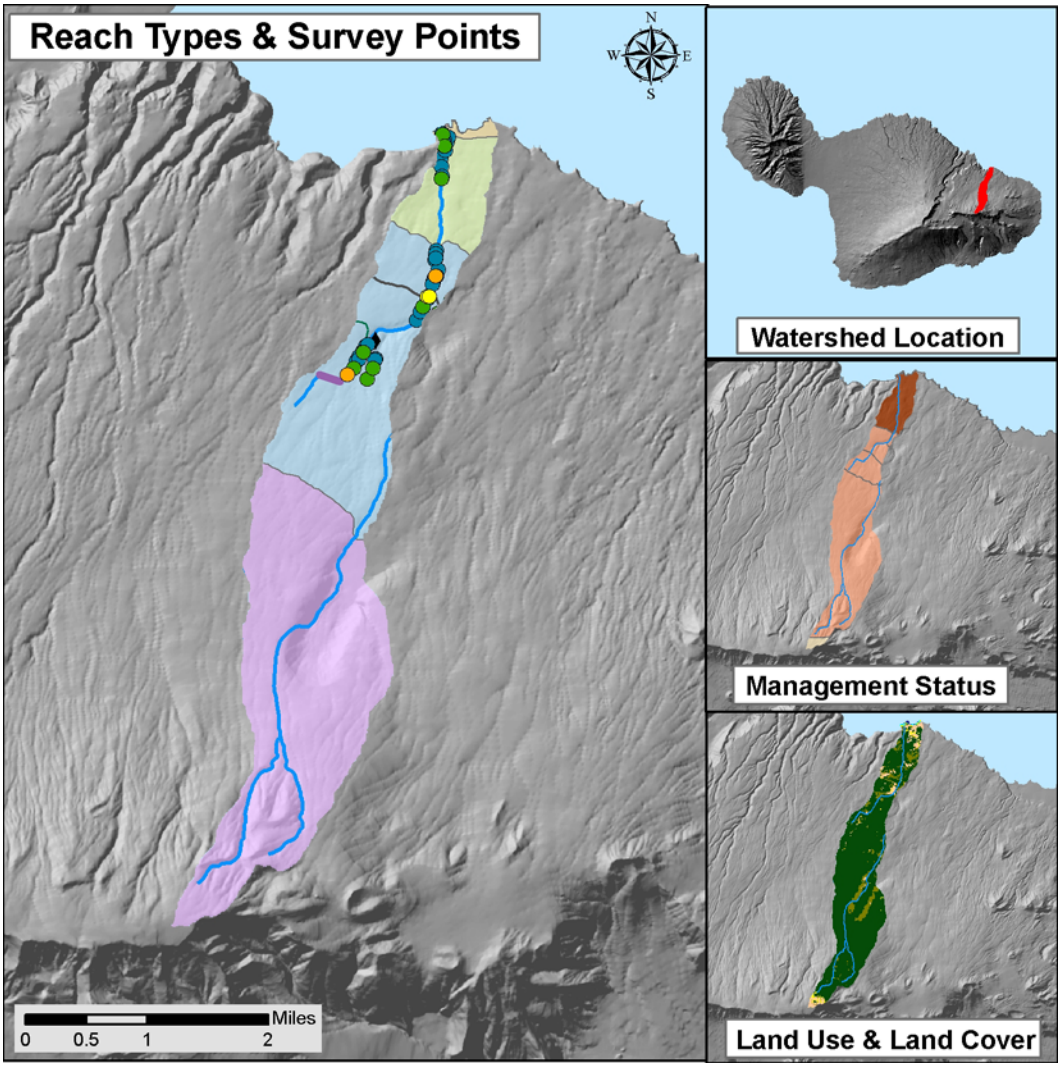
Section 2: Watershed Atlas

DAR Watershed Code: 64023

Makapipi, Maui



Watershed Features

Makapipi watershed occurs on the island of Maui. The Hawaiian meaning of the name is unknown. The area of the watershed is 5.3 square mi (13.8 square km), with maximum elevation of 7615 ft (2321 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: 15.2% agricultural, 84.8% 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	1.8	82.4	0.0	0.0	0.0	15.9

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
1.8	82.4	0.0	15.9

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	0.1	0.00	0.01
Cultivated	0.0	0.00	0.00
Grassland	3.8	0.20	0.52
Scrub/Shrub	8.1	0.43	1.12
Evergreen Forest	86.8	4.63	11.98
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	0.9	0.05	0.13
Unconsolidated Shoreline	0.2	0.01	0.02
Water	0.1	0.00	0.01
Unclassified	0.0	0.00	0.00

Stream Features

Makapipi is a perennial stream. Total stream length is 8.6 mi (13.9 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
0.0	0.9	10.9	33.8	54.4

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

Biotic Sampling Effort

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

1962	1979	1980	1990	1991	1992	1993
1995	2000	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
Damselfly Surveys	0	0	0	6	0
DAR General Surveys	0	2	2	0	0
DAR Point Quadrat	0	1	10	24	0
DAR Rapid BioAssessment	0	0	0	1	0
HDFG	0	0	0	2	0
Published Report	0	4	9	5	0

Biota Information

Species List

Native Species

Crustaceans	*Atyoida bisulcata*
Fish	*Awaous guamensis*
	Eleotris sandwicensis
	Gobiid sp.
	Kuhlia sandvicensis
	Kuhlia sp.
	Lentipes concolor
	Sicyopterus stimpsoni
Worms	Hirudinean sp.

Native Species

Insects	*Anax junius*
	Anax sp.
	Megalagrion blackburni
	Megalagrion calliphya
	Megalagrion hawaiiense
	Megalagrion nigrohamatum nigrohamatum
	Megalagrion pacificum
	Megalagrion sp.
	Saldula sp.
	Telmatogeton sp.
	Unknown Coleoptera

Introduced Species

Amphibians	*Bufo marinus*
	Rana rugosa
	Ranid sp.
Crustaceans	*Macrobrachium lar*
	Procambarus clarkii
Reptiles	*Chrysemys* sp.
Snails	Lymnaeid sp.
	Lymnea sp.

Introduced Species

Insects	*Cheumatopsyche analis*
	Chironomid sp.
	Culicid sp.
	Pantala flavescens

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

Scientific Name	Status	Minimum Size	Maximum Size	Average Size
Bufo marinus	Introduced	2.75	2.75	2.8
Atyoida bisulcata	Endemic	0.75	1.75	1.3
Macrobrachium lar	Introduced	1.5	6	2.9
Lentipes concolor	Endemic	1.5	5	2.4

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				2.97	
Lentipes concolor	Endemic			1.15	0.08	
Bufo marinus	Introduced				0.08	
Macrobrachium lar	Introduced				1.69	
Unknown Coleoptera	Unknown				0.08	

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

Scientific Name	Status	Estuary	Lower	Middle	Upper	Headwaters
Atyoida bisulcata	Endemic		P	P	P	
Eleotris sandwicensis	Endemic			P		
Lentipes concolor	Endemic		P	P	P	
Sicyopterus stimpsoni	Endemic				P	
Megalagrion blackburni	Endemic				P	
Megalagrion calliphya	Endemic				P	
Megalagrion hawaiiense	Endemic				P	
Megalagrion nigrohamatum nigrohamatum					Endemic	P
Megalagrion pacificum	Endemic				P	
Megalagrion sp.	Endemic				P	
Awaous guamensis	Indigenous		P	P		
Gobiid sp.	Indigenous		P			
Kuhlia sandvicensis	Indigenous			P		
Kuhlia sp.	Indigenous			P		
Anax junius	Indigenous				P	
Anax sp.	Indigenous				P	
Saldula sp.	Indigenous				P	
Telmatogeton sp.	Indigenous				P	
Bufo marinus	Introduced				P	
Rana rugosa	Introduced			P	P	

Ranid sp.	Introduced	P	P	P
Macrobrachium lar	Introduced	P	P	P
Cheumatopsyche analis	Introduced			P
Chironomid sp.	Introduced	P	P	P
Culicid sp.	Introduced	P	P	P
Pantala flavescens	Introduced			P
Chrysemys sp.	Introduced		P	
Lymnaeid sp.	Introduced	P	P	P
Hirudinean sp.	Undetermined			P
Unknown Coleoptera	Unknown			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	Yes	No

CURRENT WATERSHED AND STREAM RATINGS

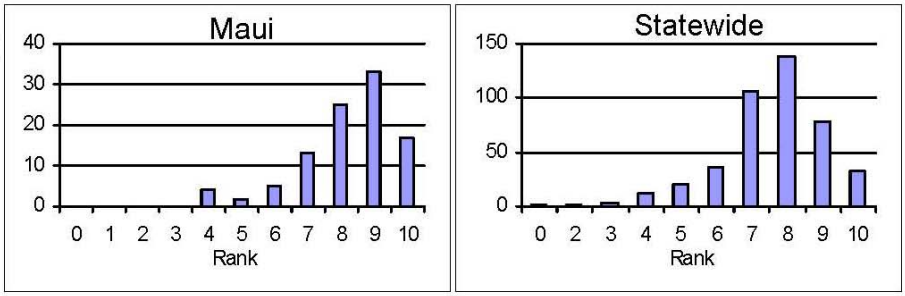
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding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

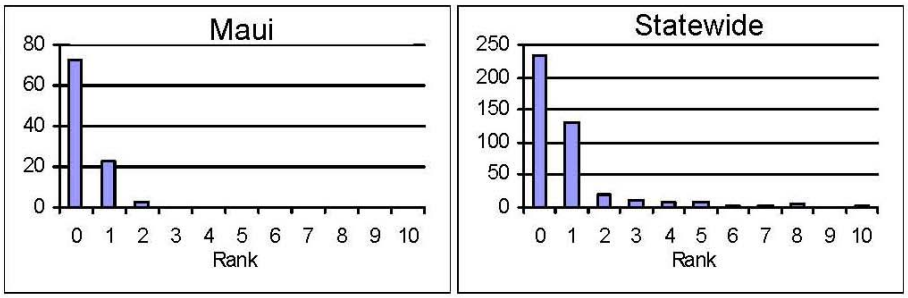
10



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

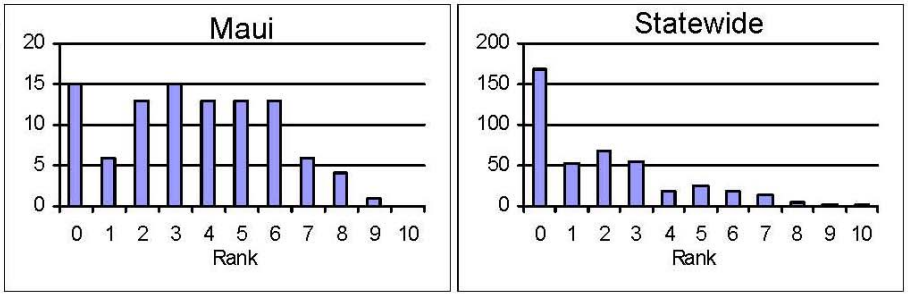
0



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

Watershed Rating

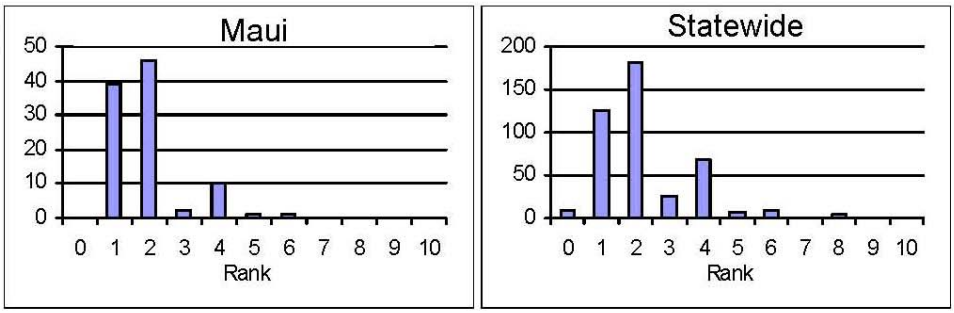
6



WATERSHED RATING (Cont): Makapipi, Maui

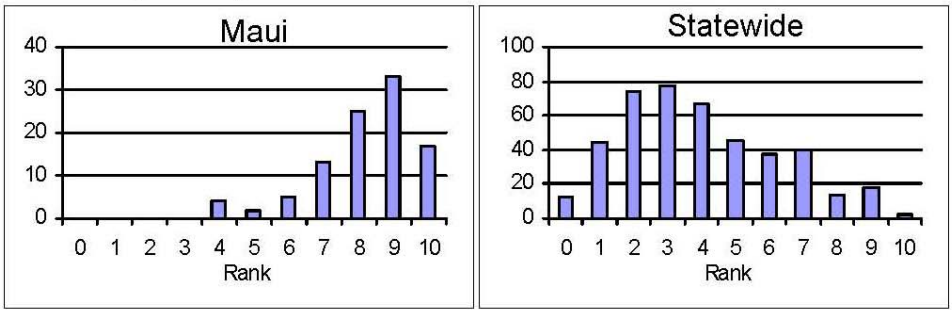
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.

Watershed Rating 1



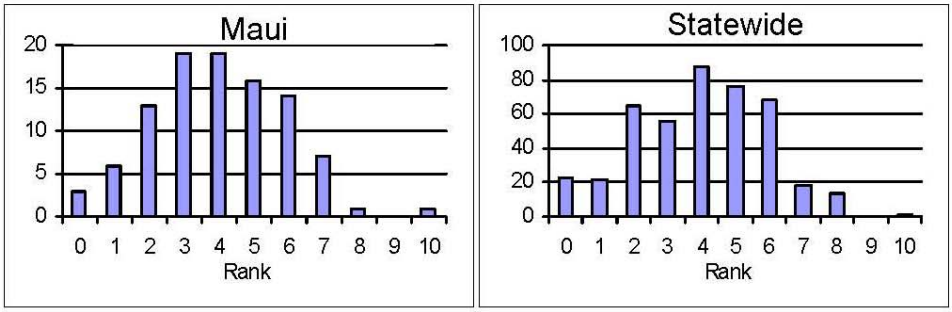
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.

Watershed Rating 9



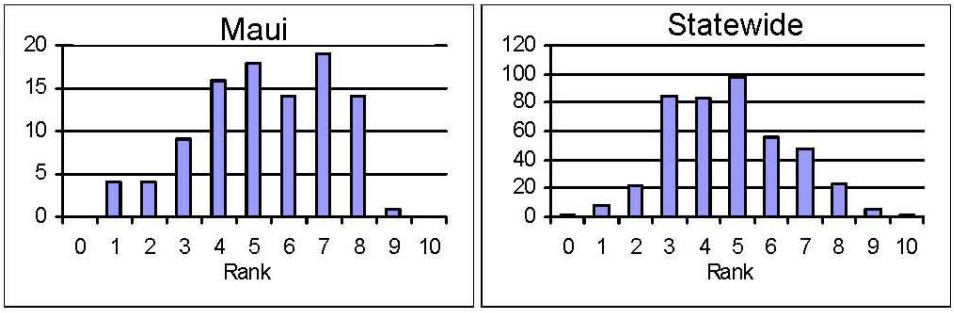
Reach Diversity Rating: Rating is based on the types and amounts of different stream reaches available in the watershed. More area in different reach types score more positively.

Watershed Rating 5



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 8

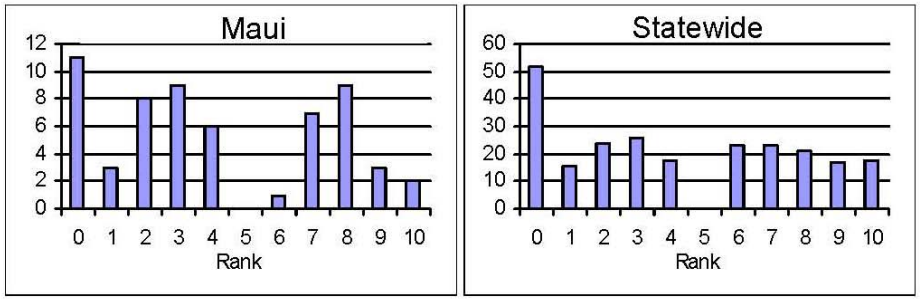


BIOLOGICAL RATING: Makapipi, Maui

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

Stream Rating

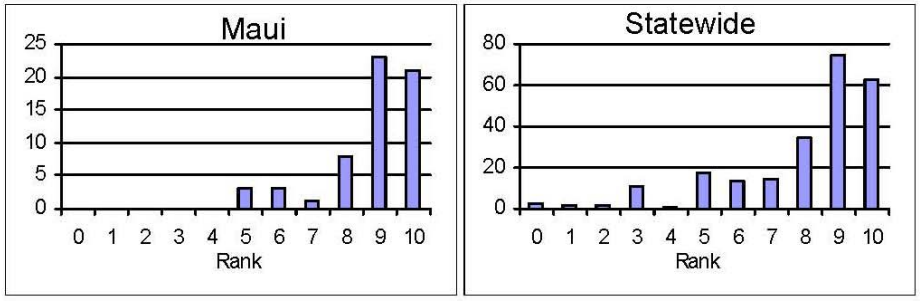
7



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

Stream Rating

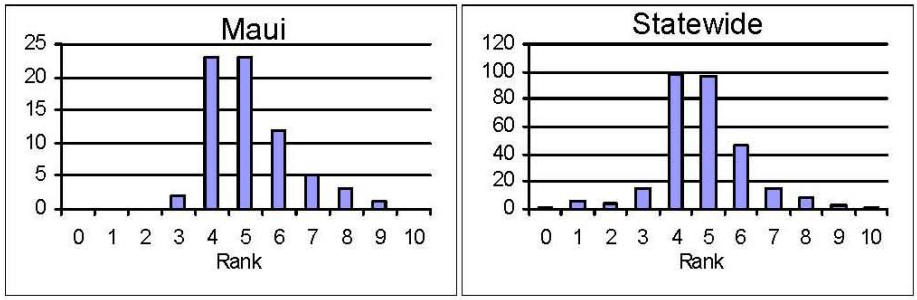
8



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

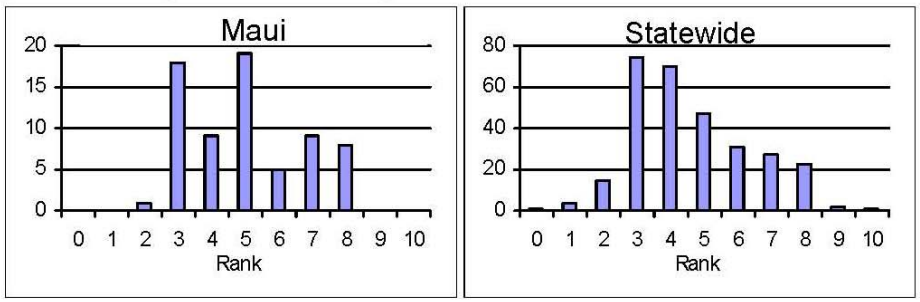
6



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

Stream Rating

6

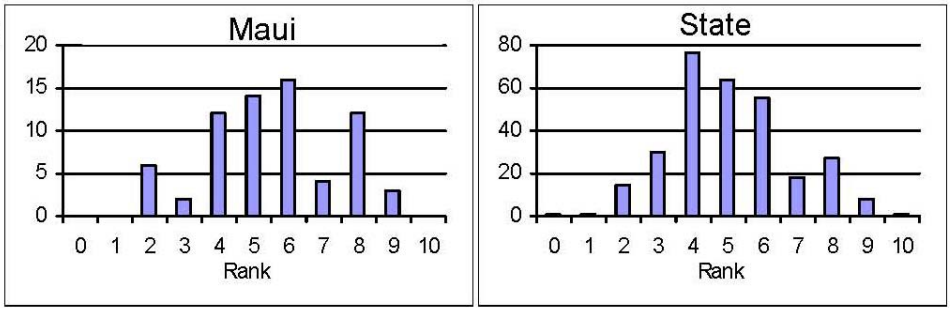


OVERALL RATING: Makapipi, Maui

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

Watershed Rating

8

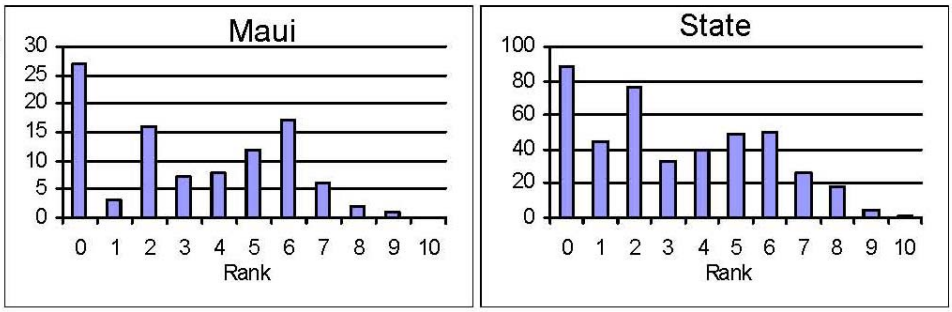


RATING STRENGTH: Makapipi, Maui

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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Section 3: DAR Point Quadrat Report

For Surveys from 2/9/2009 to 7/1/2009

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:

Makapipi (ID: 64023), 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	1
Middle	10
Upper	24
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	2	1	0	0	0	1	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	0	0	0	0	0	0	100

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

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Lower	19.71	0.077	8.51	7.29

Middle Reach

Table 3-5. 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	9	0	0	0	1	4	1	3	0	0

Table 3-6. Observed Substrates (%) in point quadrat samples in the middle stream reach.

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Middle	2	0	3	15	22	28	30

Table 3-7. Observed Water Quality in point quadrat samples in the middle stream reach.

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Middle	18.967	0.11	7.868	7.34

Table 3-8. Summary of species observed in the middle reach of the watershed.

Category	Status	Scientific Name
Crustacean	Introduced	*Macrobrachium lar*
Fish	Endemic	*Lentipes concolor*

Table 3.9. 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.

Category	Status	Scientific Name	Reach	Average Density	Total # observed
Fish	Endemic	*Lentipes concolor*	Middle	1.58	7

Upper Reach

Table 3-10. 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	20	2	0	3	5	3	0	7	0	0

Table 3-11. Observed Substrates (%) in point quadrat samples in the upper stream reach.

Reach	Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
Upper	3	1	1	8	17	24	47

Table 3-12. Observed Water Quality in point quadrat samples in the upper stream reach.

Reach	Temp (º C)	sCond (mS/cm)	DO (mg/L)	pH
Upper	20.837	0.057	7.999	7.727

Table 3-13. Summary of species observed in the upper reach of the watershed.

Category	Status	Scientific Name
Amphibian	Introduced	*Bufo marinus*
Crustacean	Introduced	*Macrobrachium lar*
Crustacean	Endemic	*Atyoida bisulcata*
Fish	Endemic	*Lentipes concolor*
Insect	Unknown	Unknown Coleoptera

Table 3-14. 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
Amphibians	Introduced	*Bufo marinus*	Upper	0.08	1
Crustaceans	Introduced	*Macrobrachium lar*	Upper	1.75	21
Crustaceans	Endemic	*Atyoida bisulcata*	Upper	4.08	49
Fish	Endemic	*Lentipes concolor*	Upper	0.08	1
Insects	Unknown	Unknown Coleoptera	Upper	0.08	1

Table 3-15. Flow data taken during point quadrat in the lower stream reach.

Latitude	Longitude	Total CFS	MGD
20.82704	-156.09383	0.08	0.05

Table 3-16. Flow data taken during point quadrat in the upper stream reach.

Latitude	Longitude	Total CFS	MGD
20.81002	-156.09494	0.3	0.19
20.80476	-156.09749	0.04	0.03
20.80110	-156.10448	1.47	0.95
20.79993	-156.10526	1.75	1.13

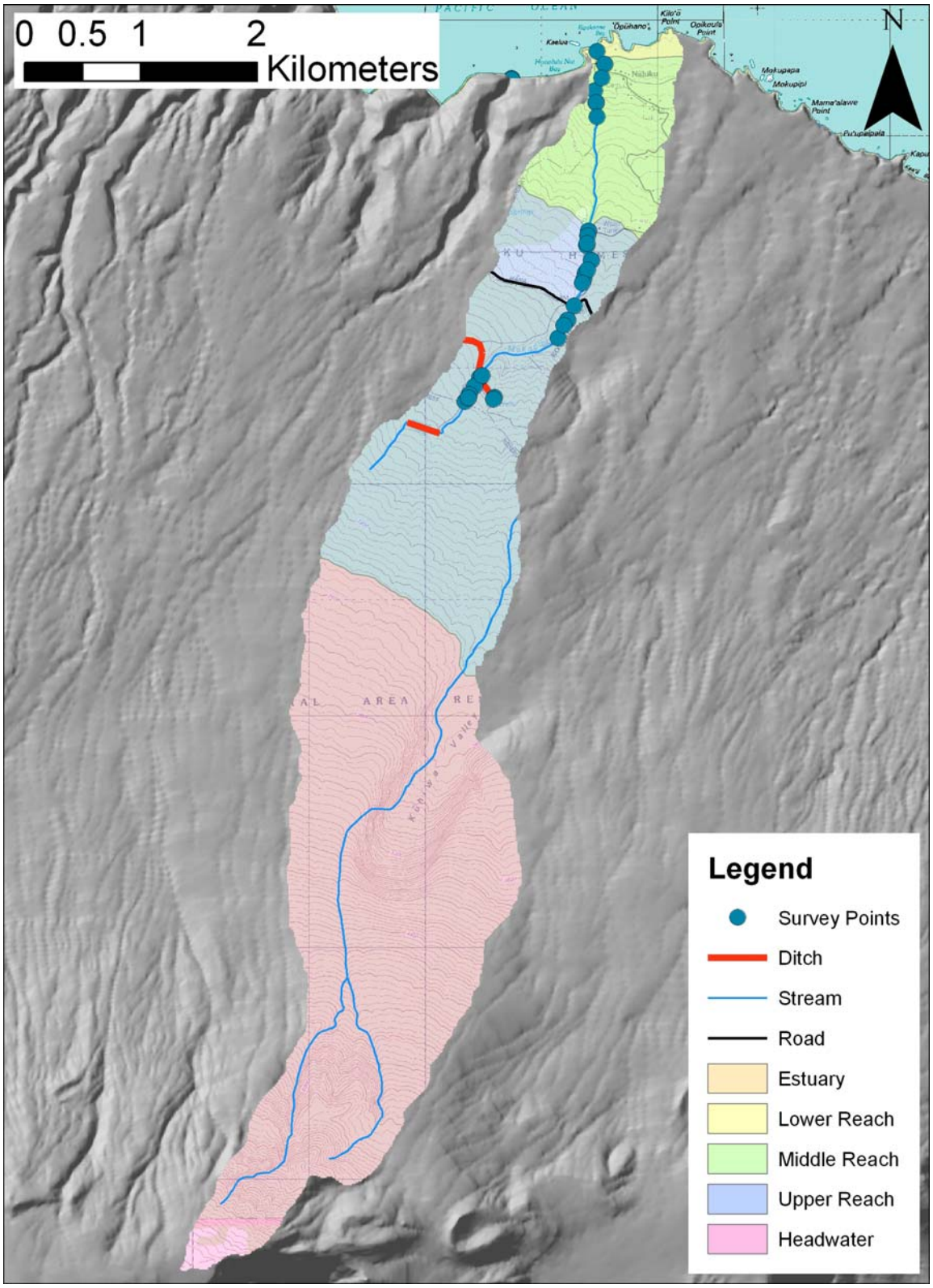

Figure 3-1. Location of point quadrat surveys conducted in Makapipi Stream.

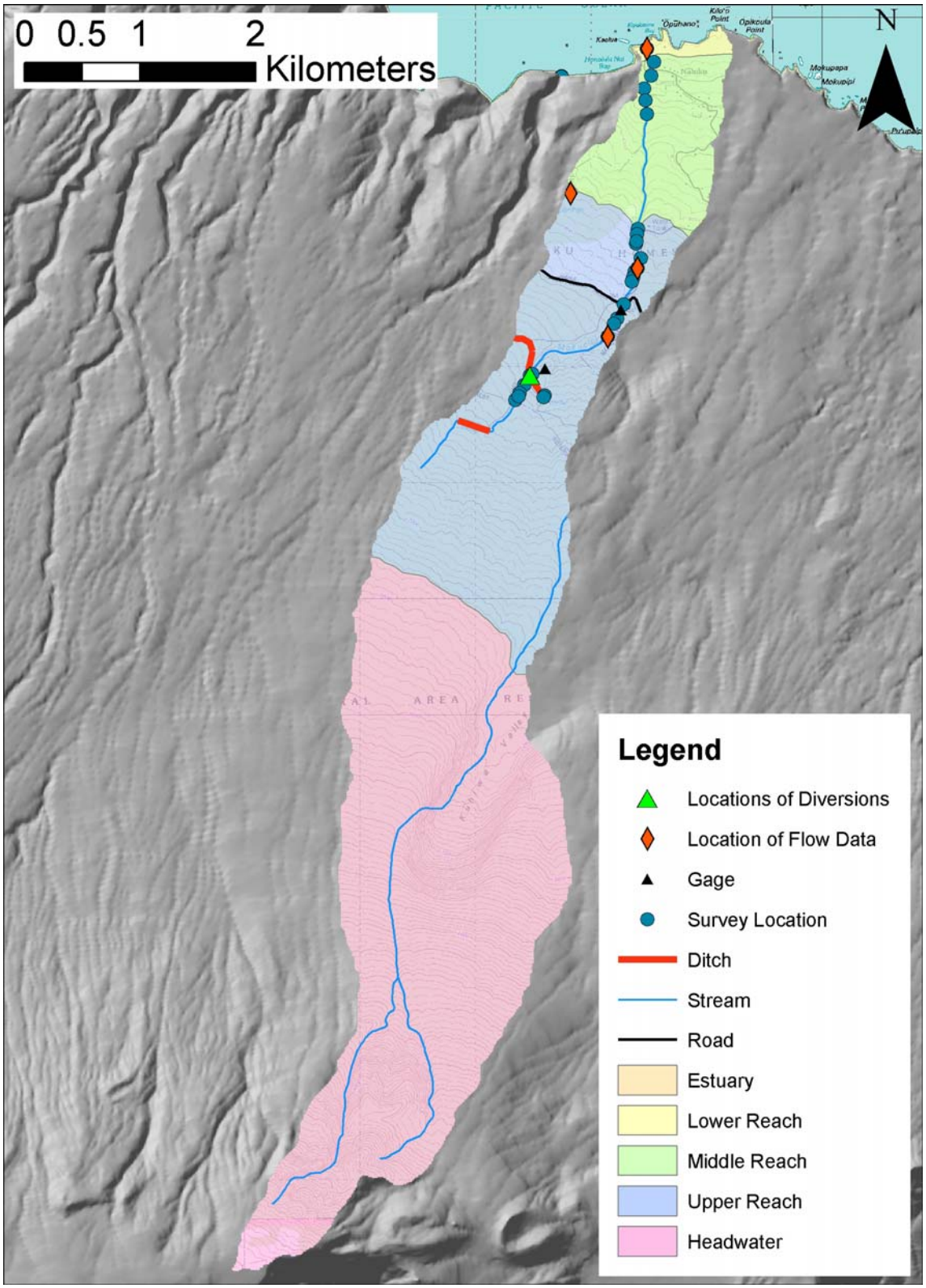

Figure 3-2. Locations of diversions surveys and flow surveys conducted in Makapipi Stream.

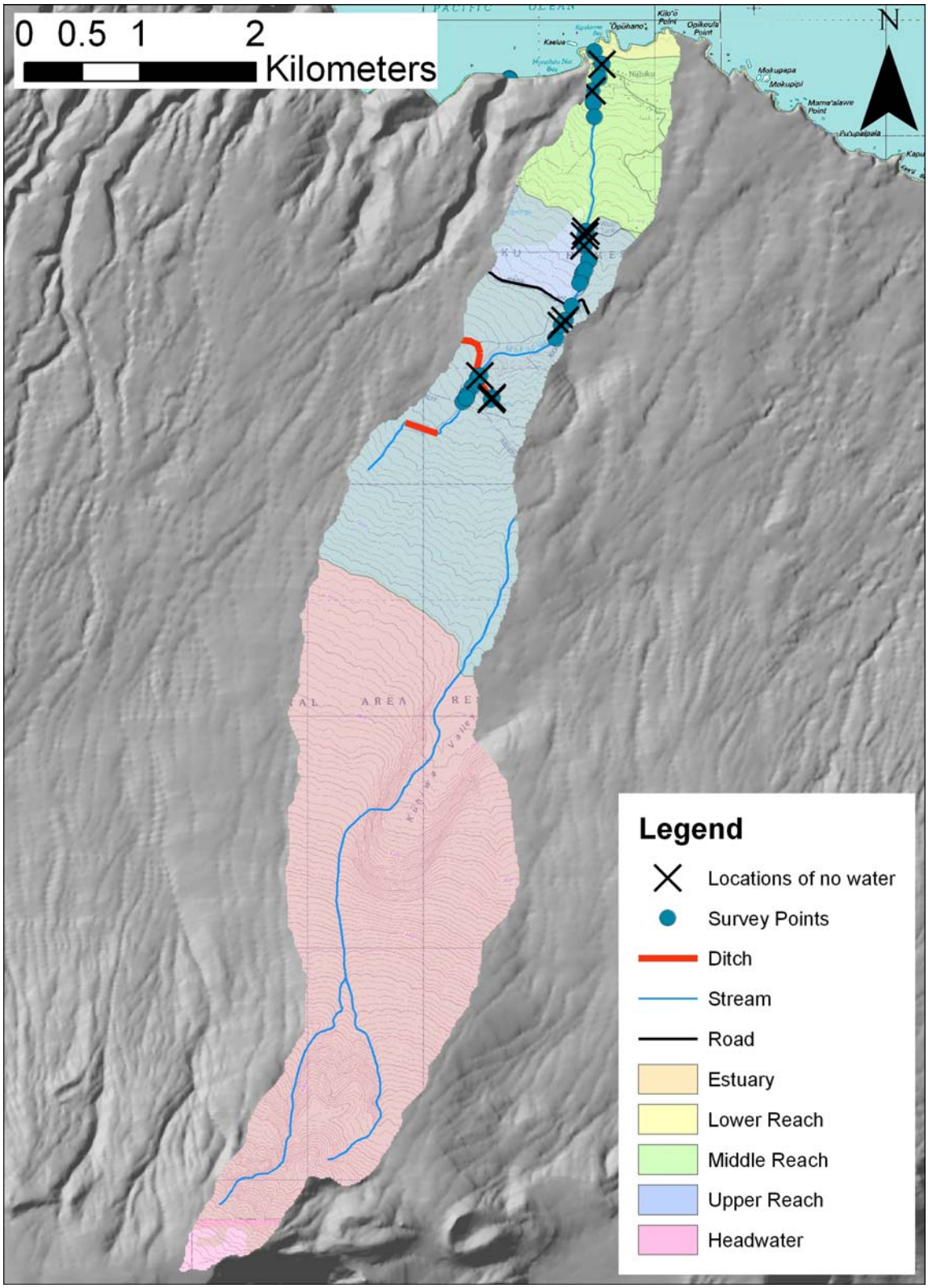

Figure 3-3. Locations of surveys of no water conditions in Makapipi Stream.

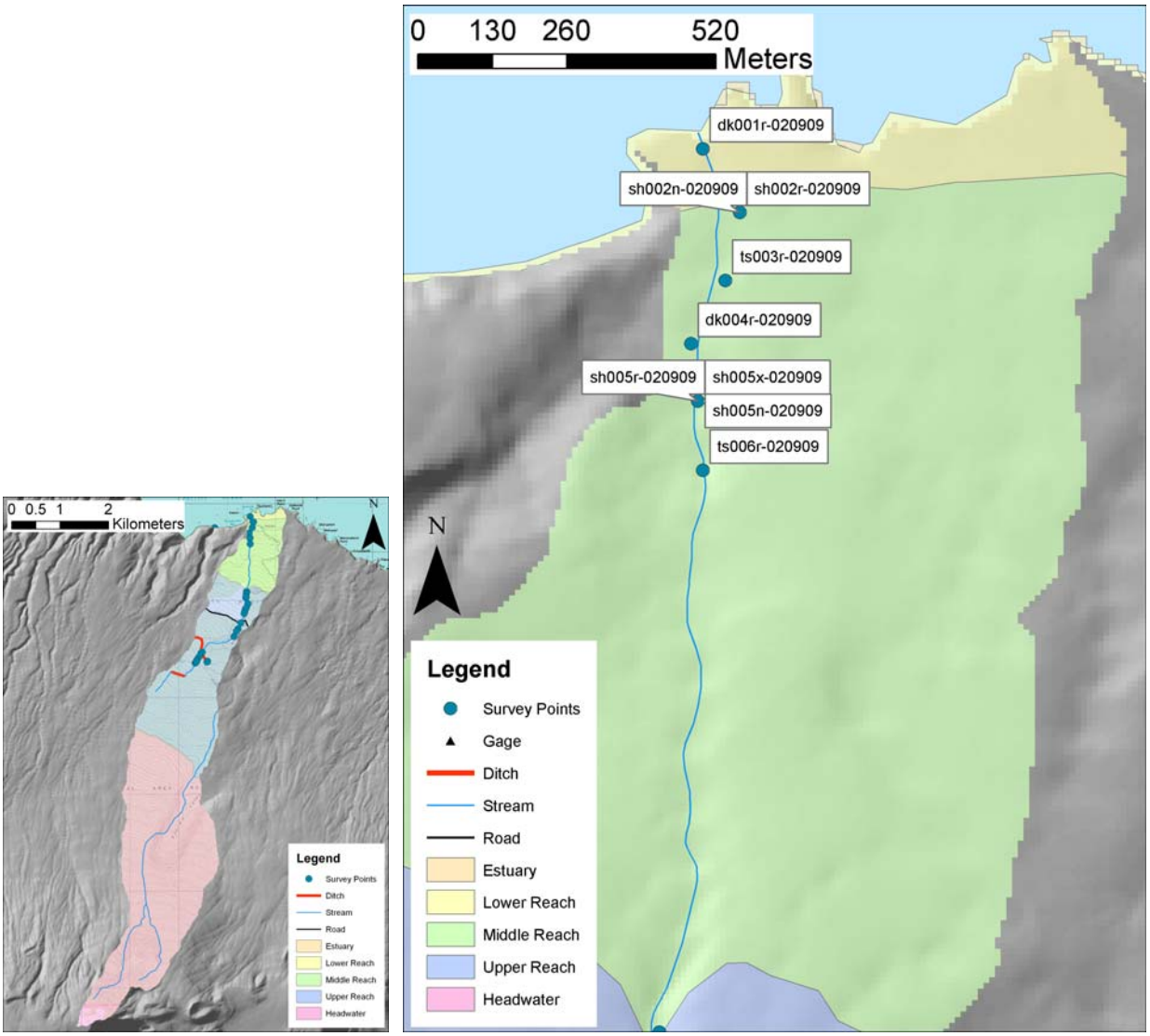

Figure 3-4. Point-quadrat survey locations in the lower reach of Makapipi Stream.

Upper Reach

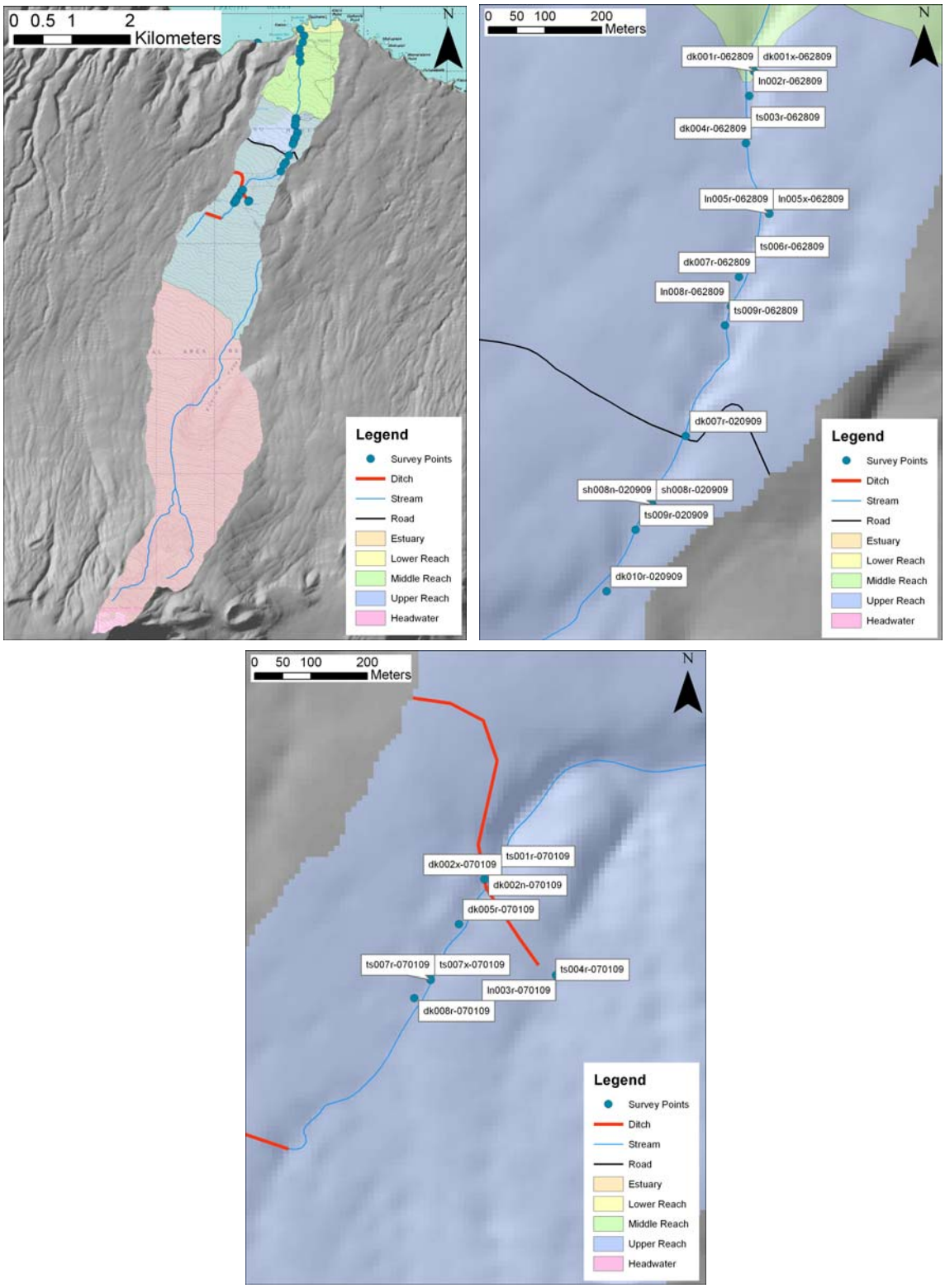

Figure 3-5. Point-quadrat survey locations in the upper reach of Makapipi Stream.

Summary

Surveys were conducted in Makapipi Stream on 28 June and 1 July 2009. A total of 770 m of stream length was surveyed in three discrete sections (470 m, 275 m, 25 m). Water flow data was collected at 3 sites and one diversion was observed in the survey area.

Animal species observed in Makapipi Stream during 28 June and 1 July 2009 surveys:

Category	Status	Scientific Name
Crustacean	Introduced	*Macrobrachium lar*
Crustacean	Endemic	*Atyoida bisulcata*
Fish	Endemic	*Lentipes concolor*
Insect	Unknown	Unknown Coleoptera

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Section 4: Photographs Taken During Stream Surveys

Lower Reach

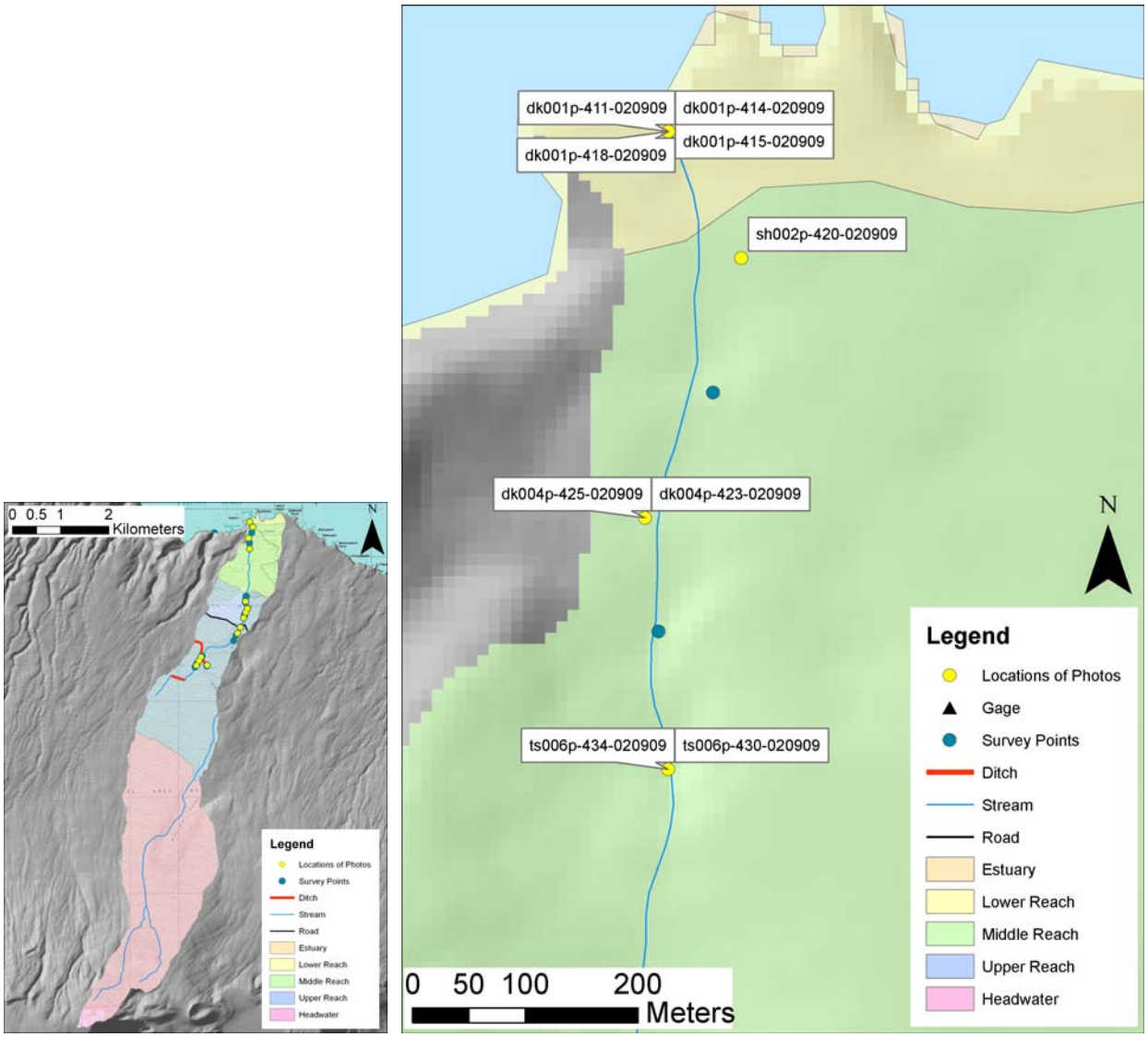

Figure 4-1. Photo locations in the lower and middle reaches of Makapipi Stream.

Figure 4-2. Photo taken of the mouth of Makapipi Stream downstream from survey site 1. (2/9/2009; Tributary name: (64023001); PBN: dk001p-411-020909; Surveyor: Kuamoʻo, D.; SBN: dk001r-020909; Lat. (DD): 20.82704, Long. (DD): -156.09383).

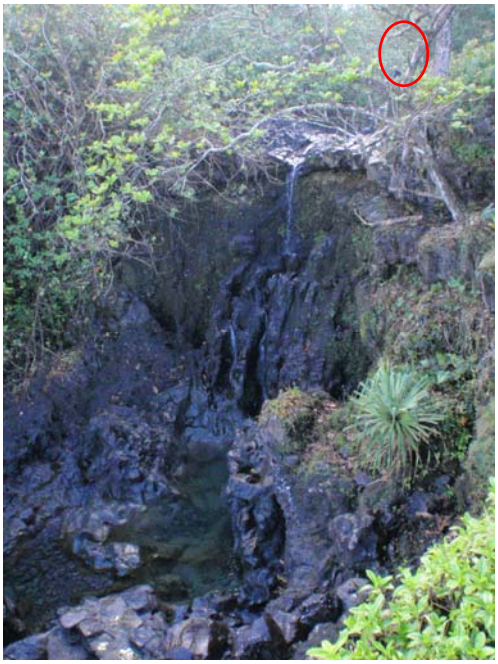

Figure 4-3. Photo from shoreline upstream of stream mouth shows a trickle of a waterfall almost at the shoreline. Flow measurements were taken at top of the waterfall. Note DAR staff member (red oval) on the top right of photo. (2/9/2009; Tributary name: (64023001); PBN: dk001p-405-020909; Surveyor: Kuamoʻo, D.; Habitat type: Run; SBN: dk001r-020909; Lat. (DD): 20.82704, Long. (DD): -156.09383).

Figure 4-4. Measuring flow at survey site 1, note minimal water flow. Photo taken downstream. (2/9/2009; Tributary name: (64023001), PBN: dk001p-414-020909; Surveyor: Kuamoʻo, D.; Habitat type: Run; SBN: dk001r-020909; Lat. (DD): 20.82704, Long. (DD): -156.09383).

Figure 4-5. The stream bed with minimal flow oriented upstream of site 1. (2/9/2009; Tributary name: (64023001), PBN: dk001p-418-020909; Surveyor: Kuamoʻo, D.; Habitat type: Run; SBN: dk001r-020909, Lat. (DD): 20.82704, Long. (DD): -156.09383).

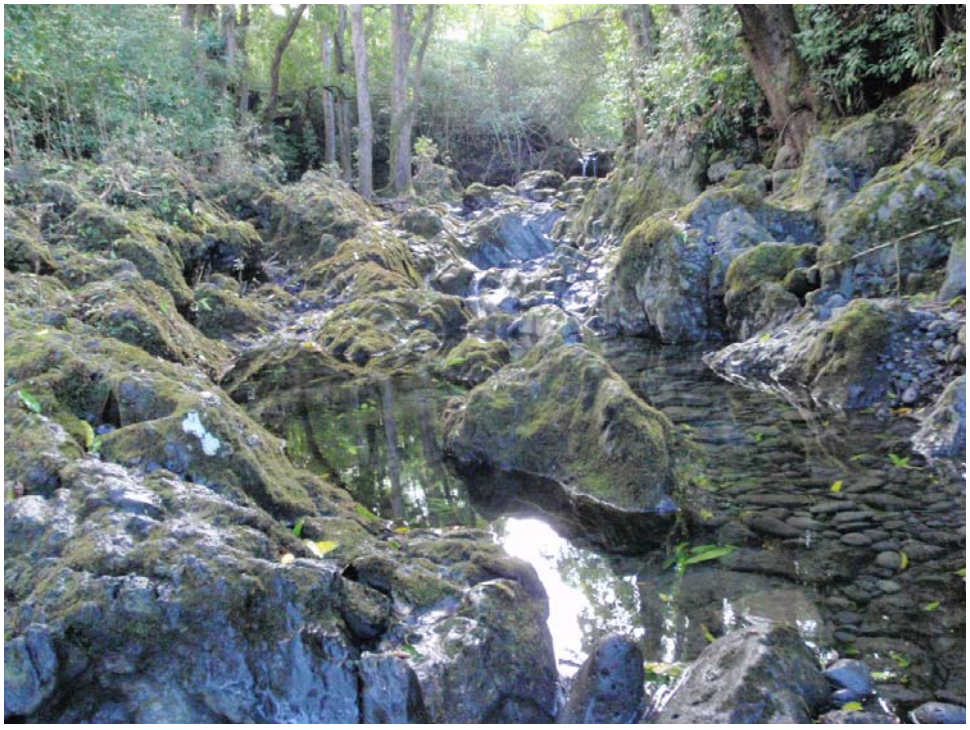

Figure 4-6. Photo is the surrounding area of survey site 2 and is oriented in an upstream direction. (2/9/2009; Tributary name: (64023001); PBN: sh002p-420-020909; Surveyor: Hau, S.; Habitat type: Run; SBN: sh002n-020909; Lat. (DD): 20.82602, Long. (DD): -156.09323).

Figure 4-7. A spring-fed pool oriented downstream of survey site 4. (2/9/2009; Tributary name: (64023001); PBN: dk004p-423-020909; Surveyor: Kuamoʻo, D.; Habitat type: No Water; SBN: dk004r-020909; Lat. (DD): 20.82396, Long. (DD): -156.09409).

Figure 4-8. A dry stream bed at site 4. Photo taken upstream at site 4. (2/9/2009; Tributary name: (64023001); PBN: dk004p-425-020909; Surveyor: Kuamoʻo, D.; Habitat type: No Water; SBN: dk004r- 020909, Lat. (DD): 20.82396, Long. (DD): -156.09409).

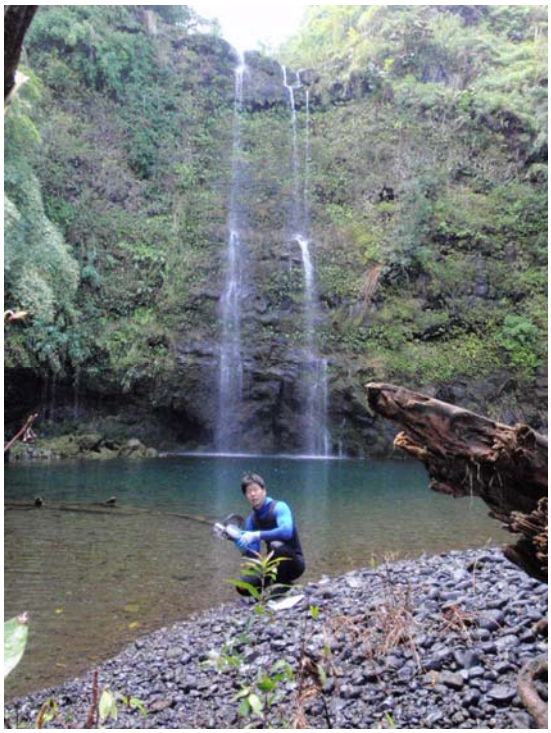

Figure 4-9. A plunge pool in oriented upstream of survey site 6. (2/9/2009; Tributary name: (64023001); PBN ts006p-434-020909; Surveyor: Shimoda, T.; Habitat type: Pool; SBN: ts006r-020909; Lat. (DD): 20.82195, Long. (DD): -156.09393).

Figure 4-10. Photo of waterfall wall above survey site 6. Note Myconia (red oval) growing on the side of the mountain. (2/9/2009; Tributary name: (64023001); PBN: ts006p-430-020909; Surveyor: Shimoda, T.; Habitat type: Pool; SBN: ts006r-020909; Lat. (DD): 20.82195, Long. (DD): -156.09393).

Upper Reach

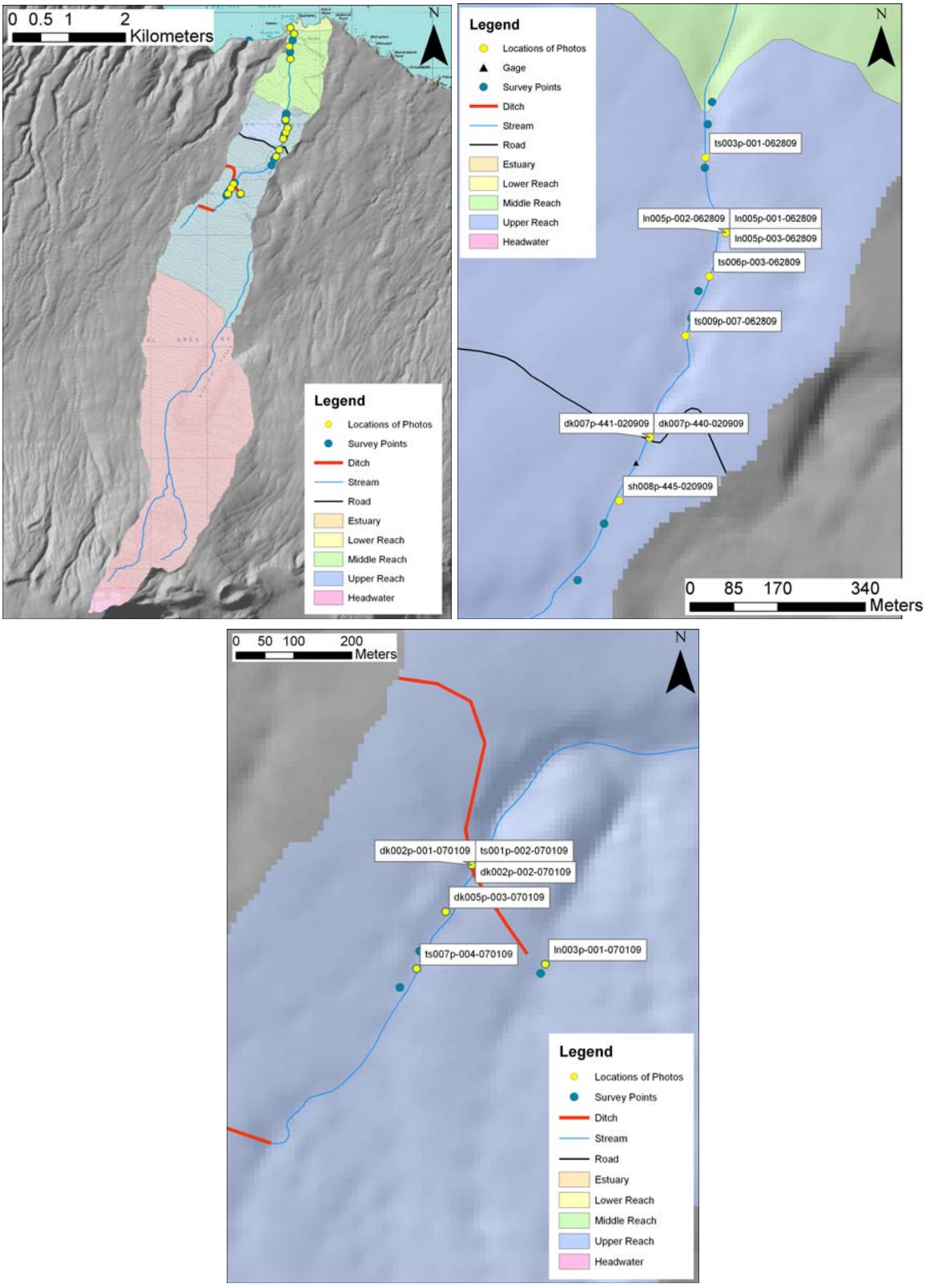

Figure 4-11. Photo locations in the upper reach of Makapipi Stream.

Figure 4-12. Photo was taken upstream of survey site 3. Dry waterfall and plunge pool below Hāna Hwy. Note Quanta Hydrolab and Garmin GPS on lower right corner of picture. (6/28/2009; Tributary name: (64023001); PBN: ts003p-001-062809; Surveyor: Shimoda, T.; Habitat type: Plunge Pool; SBN: ts003r-062809; Lat. (DD): 20.81210, Long. (DD): -156.09497).

Figure 4-13. Photo is oriented in a downstream direction from the survey site 5 and shows that the water flow goes underground. (6/28/2009; Tributary name: (64023001); PBN: ln005p-001-062809; Surveyor: Nishiura, L.; Habitat type: Pool; SBN: ln005r-062809; Lat. (DD): 20.81078, Long. (DD): -156.09462).

Figure 4-14. Photo is taken in an upstream direction from the survey site 5 and shows a small waterfall below Hāna Hwy. (6/28/2009; Tributary name: (64023001); PBN: ln005p-002-062809; Surveyor: Nishiura, L.; Habitat type: Pool; SBN: ln005r-062809; Lat. (DD): 20.81078, Long. (DD): 156.09462).

Figure 4-15. Photo is of the survey site 5. (6/28/2009, Tributary name: (64023001); PBN: ln005p-003-062809; Surveyor: Nishiura, L.; Habitat type: Pool; SBN: ln005r-062809, Lat. (DD) 20.81078, Long. (DD): -156.09462).

Figure 4-16. Stream flow measurements taken downstream of survey site 6 and below Hāna Hwy. (6/28/2009; Tributary name: (64023001); PBN: ts006p-003-062809; Surveyor: Shimoda, T.; Habitat type: Run; SBN: 123; Lat. (DD): 20.81002, Long. (DD): -156.09494).

Figure 4-17. Photo was taken downstream of survey site 9 and is oriented in an upstream direction. It shows the waterfall and plunge pool below Hāna Hwy. (6/28/2009; Tributary name: (64023001); PBN: ts009p-007-062809; Surveyor: Shimoda, T.; Habitat type: Plunge Pool; SBN: ts009r-062809; Lat. (DD): 20.80900, Long. (DD): -156.09540).

Figure 4-18. Photo shows DAR staff surveying site 7 right below Hāna Hwy. Photo is taken upstream. (2/9/2009; Tributary name: (64023001); PBN: dk007p-441-020909; Surveyor: Kuamoʻo, D.; Habitat type: Run; SBN: dk007r-020909; Lat. (DD): 20.80723, Long. (DD): -156.09610).

Figure 4-19. Pool a few meters below survey site 7 in previous photo (Fig. 3-17.) Photo is taken looking downstream into the pool. (2/9/2009; Tributary name: (64023001); PBN: dk007p-440-020909; Surveyor: Kuamoʻo, D.; Habitat type: Run; SBN: dk007r-020909; Lat. (DD): 20.80723, Long. (DD): -156.09610).

Figure 4-20. Dry stream bed at survey site 8. Photo taken upstream from site 8. (2/9/2009; Tributary name: (64023001); PBN: sh008p-445-020909; Surveyor: Hau, S.; Habitat type: Pool; SBN: sh008n-020909; Lat. (DD): 20.80614, Long. (DD): -156.09669).

Figure 4-21. Photo of diversion above Hāna Hwy. Image is taken upstream from survey site 1. (7/1/2009; Tributary name: (64023001); PBN: ts001p-002-070109; Surveyor: Kuamoʻo, D.; SBN: dk001d-070109; Lat. (DD): 20.80182, Long. (DD): -156.10403).

Figure 4-22. Photo of the waterfall above the diversion. (7/1/2009, Tributary name: (64023001); PBN: dk002p-002-070109; Surveyor: Kuamo‘o, D.; SBN: dk001d-070109; Lat. (DD): 20.80182, Long. (DD): -156.10403).

Figure 4-23. Photo is upstream of the survey site at the diversion. (7/1/2009; Tributary name: (64023001); PBN: dk002p-001-070109; Surveyor: Kuamo‘o, D.; SBN: dk001d-070109; Lat. (DD): 20.80182, Long. (DD): -156.10403).

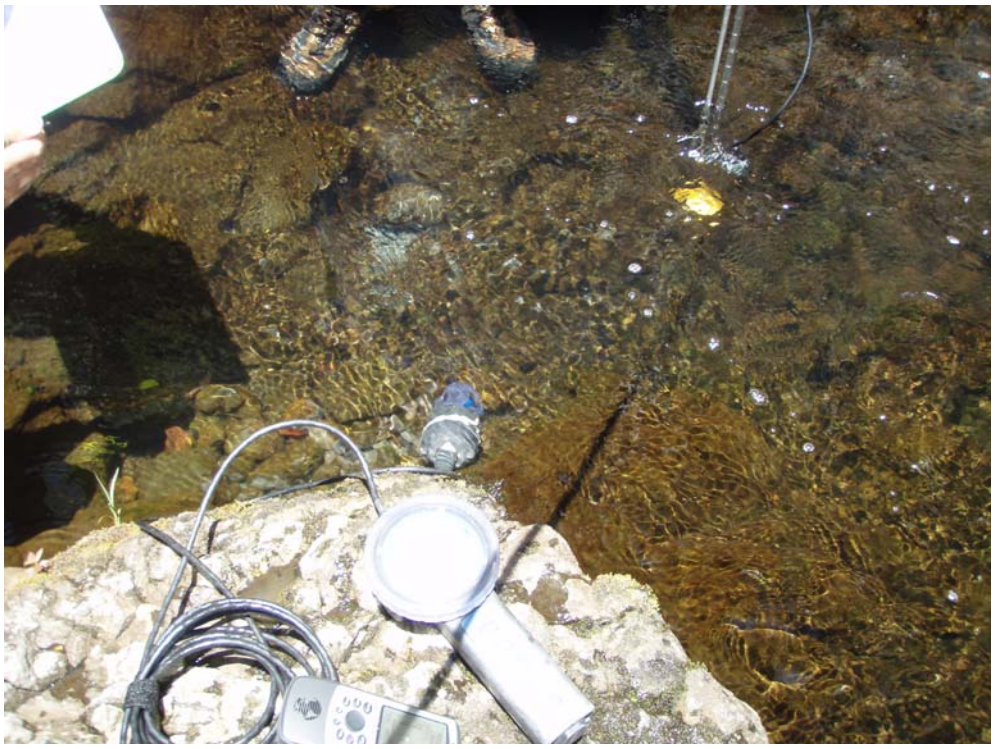

Figure 4-24. Photo showing location of the flow measurement site above diversion-last site. (7/1/2009; Tributary name: (64023001); PBN: dk005p-003-070109; Surveyor: Kuamoʻo, D.; Habitat type: Run; SBN: 136, Lat. (DD): 20.80110, Long. (DD): -156.10448).

Figure 4-25. Photo of survey site 7 taken in an upstream direction. (7/1/2009; Tributary name: (64023001); PBN: ts007p-004-070109, Surveyor: Shimoda, T.; Habitat type: Run; SBN: ts007r-070109; Lat. (DD): 20.80022, Long. (DD): -156.10498).

Figure 4-26. Photo of survey site 3 on East Makapipi tributary looking upstream. (7/1/2009; Tributary name: (64023001); PBN: ln003p-001-070109; Surveyor: Nishiura, L.; Habitat type: No Water; SBN: ln003r-070109; Lat. (DD): 20.80025, Long. (DD): -156.10284).

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Appendix: Survey Sites Latitude and Longitude

Tributary	Stream	Survey Book #	Site	Surveyor	Date	Latitude	Longitude
64023001	Makapipi	dk001r-020909	1	Kuamo‘o, Darrell	2/9/2009	20.82704	-156.09383
64023001	Makapipi	sh002r-020909	2	Hau, Skippy	2/9/2009	20.82602	-156.09323
64023001	Makapipi	sh002n-020909	2	Hau, Skippy	2/9/2009	20.82602	-156.09323
64023001	Makapipi	ts003r-020909	3	Shimoda, Troy	2/9/2009	20.82495	-156.09349
64023001	Makapipi	dk004r-020909	4	Kuamo‘o, Darrell	2/9/2009	20.82396	-156.09409
64023001	Makapipi	sh005x-020909	5	Hau, Skippy	2/9/2009	20.82305	-156.09399
64023001	Makapipi	sh005n-020909	5	Hau, Skippy	2/9/2009	20.82305	-156.09399
64023001	Makapipi	sh005r-020909	5	Hau, Skippy	2/9/2009	20.82305	-156.09399
64023001	Makapipi	ts006r-020909	6	Shimoda, Troy	2/9/2009	20.82195	-156.09393
64023001	Makapipi	dk007r-020909	7	Kuamo‘o, Darrell	2/9/2009	20.80723	-156.09610
64023001	Makapipi	sh008r-020909	8	Hau, Skippy	2/9/2009	20.80614	-156.09669
64023001	Makapipi	sh008n-020909	8	Hau, Skippy	2/9/2009	20.80614	-156.09669
64023001	Makapipi	ts009r-020909	9	Shimoda, Troy	2/9/2009	20.80574	-156.09698
64023001	Makapipi	dk010r-020909	10	Kuamo‘o, Darrell	2/9/2009	20.80476	-156.09749
64023001	Makapipi	dk001x-062809		Kuamo‘o, Darrell	6/28/2009	20.81307	-156.09483
64023001	Makapipi	ln005x-062809		Nishiura, Lance	6/28/2009	20.81078	-156.09462
64023001	Makapipi	dk001r-062809	1	Kuamo‘o, Darrell	6/28/2009	20.81307	-156.09483
64023001	Makapipi	ln002r-062809	2	Nishiura, Lance	6/28/2009	20.81268	-156.09492
64023001	Makapipi	ts003r-062809	3	Shimoda, Troy	6/28/2009	20.81210	-156.09497
64023001	Makapipi	dk004r-062809	4	Kuamo‘o, Darrell	6/28/2009	20.81192	-156.09499
64023001	Makapipi	ln005r-062809	5	Nishiura, Lance	6/28/2009	20.81078	-156.09462
64023001	Makapipi	ts006r-062809	6	Shimoda, Troy	6/28/2009	20.81002	-156.09494
64023001	Makapipi	dk007r-062809	7	Kuamo‘o, Darrell	6/28/2009	20.80977	-156.09515
64023001	Makapipi	ln008r-062809	8	Nishiura, Lance	6/28/2009	20.80930	-156.09529
64023001	Makapipi	ts009r-062809	9	Shimoda, Troy	6/28/2009	20.80900	-156.09540

Appendix: Survey Sites Latitude and Longitude (continued)

Tributary	Stream	Survey Book #	Site	Surveyor	Date	Latitude	Longitude
64023001	Makapipi	ts001r-070109	1	Shimoda, Troy	7/1/2009	20.80195	-156.10381
64023001	Makapipi	dk002n-070109	2	Kuamo‘o, Darrell	7/1/2009	20.80182	-156.10403
64023001	Makapipi	dk002x-070109		Kuamo‘o, Darrell	7/1/2009	20.80182	-156.10403
64023001	Makapipi	ln003r-070109	3	Nishiura, Lance	7/1/2009	20.80025	-156.10284
64023001	Makapipi	ts004r-070109	4	Shimoda, Troy	7/1/2009	20.80011	-156.10292
64023001	Makapipi	dk005r-070109	5	Kuamo‘o, Darrell	7/1/2009	20.80110	-156.10448
64023001	Makapipi	ln006r-070109	6	Nishiura, Lance	7/1/2009	20.80049	-156.10492
64023001	Makapipi	ts007r-070109	7	Shimoda, Troy	7/1/2009	20.80022	-156.10498
64023001	Makapipi	dk008r-070109	8	Kuamo‘o, Darrell	7/1/2009	20.79993	-156.10526