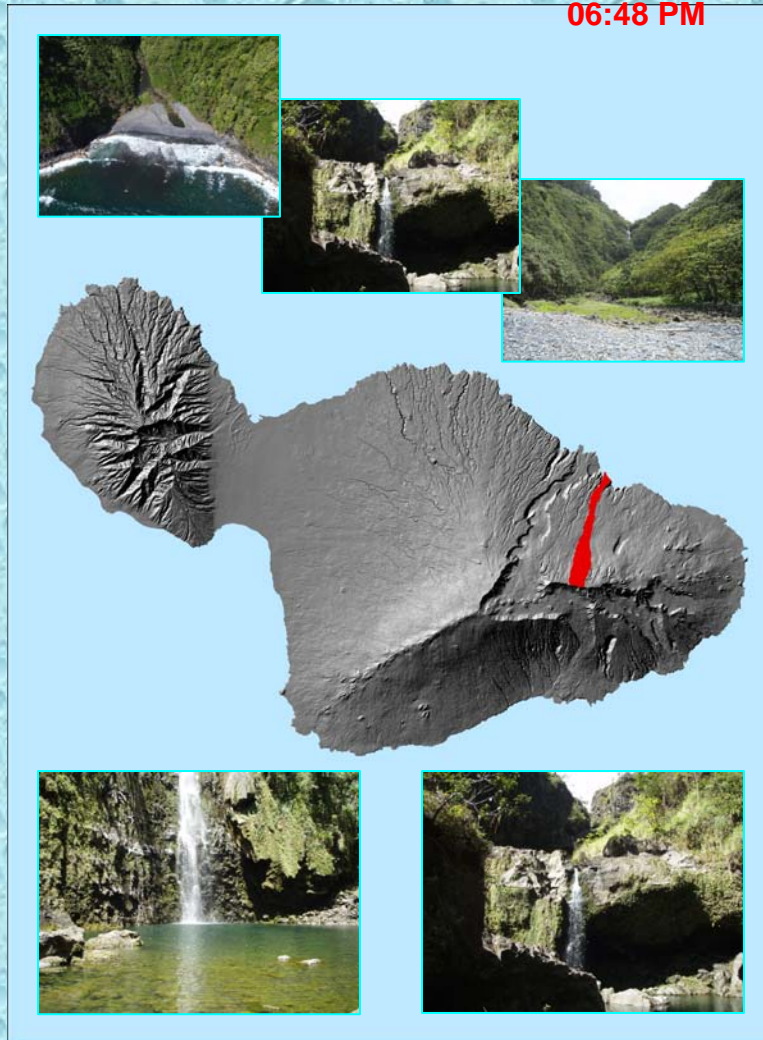


Report on Kopili'ula Stream Maui, Hawaii

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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
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and



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Report on Kopili‘ula 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 Kopili‘ula Stream, Maui from the year 2000 to the present. The focus of this report is on the animals and insects that live in the stream and the data collected during surveys. The report covers five main sections, including:

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

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a description of the watershed and its aquatic resources from Division of Aquatic Resources (DAR) and other published/unpublished surveys, including a rating of the condition of the stream compared to other streams on Maui as well as statewide.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

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

Findings for Kopili‘ula Stream, Maui:

Kopili‘ula is a small (4.8 sq miles), narrow watershed that is steep in the upper sections with little embayment. It is fully zoned for conservation (100%) and the land cover is mostly

evergreen forest (82%), scrub (10%), grassland (5%) and bare land (3%). Numerous stream surveys of different types have been completed in Kopili'ula Stream beginning in 1962 to the present. This watershed rates high 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 7 out of 10, and a combined overall rating of 8 out of 10.

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

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

Crustaceans - *Atyoida bisulcata*

Insect – *Telmatogen* sp.

Mollusks - *Neritina granosa*

Sponge - *Heteromeyenia baileyi*

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

Amphibian – *Rana rugosa*

Crustaceans - *Macrobrachium lar*

Mollusks – Physid sp.

Discussion:

Kopili'ula watershed is narrow and steep with a small embayment at the stream mouth. Aerial photographs show a profile characterized by a series of stair casing waterfalls and pools below and above Hāna Highway. In the lower reach, Kopili'ula Stream forks and has a tributary, Pua'aka'a Stream connecting to the main stem of Kopili'ula Stream on the left. The main stream continues on the right (looking upstream).

A helicopter was used to access the different reaches of Kopili'ula Stream during the surveys of the estuary and other reaches because of watersheds steepness and inaccessibility by foot. There was no access to the stream from Hāna Highway.

The stream mouth was closed during the time of the estuary survey in May. However, aerial reconnaissance photos in April, 2009 showed that the stream mouth was open to the ocean probably due to heavy rain events in March and April (Skippy Hau, DAR, personal observation) which results in strong stream flow that clears the stream mouth. Heavy north swells in May have closed off the mouth before our survey as the large waves deposit sand, gravel, and cobble on the beach and across the stream mouth if stream flows are too low to keep the mouth open. The opening and closing of stream mouths is a natural occurrence for many Hawaiian streams, although lower stream flows resulting from stream diversion likely increase the amount of time the stream mouth is closed by a berm. This can decrease the chance for postlarval amphidromous animals to recruit to the stream and for larvae to drift back to the ocean.

Cast net sampling resulted in only one specimen of Hawaiian surf fish, a species which usually inhabits high salinity areas. The estuary is relatively small compared to other streams and there was not much estuarine habitat available. Given the small size of the estuary, additional stream flow may cause the stream-mouth berm to be open more frequently, but it is unlikely that additional stream flow would result in substantial increases in estuarine habitats.

Point quadrat surveys were conducted in Kopili‘ula Stream from the mouth to the upper reach. A tributary, Pua‘aka‘a Stream, connecting in the lower reach to Kopili‘ula Stream was surveyed only to the first major waterfall. Measurements of stream discharge showed that more water was flowing in the Pua‘aka‘a Stream tributary (4.6 cfs) than in the main channel of Kopili‘ula Stream (1.4 cfs). Both streams are diverted in the upper reaches above Hāna Highway.

Kopili‘ula Stream had water depths and water temperatures suitable for providing habitat for native stream animals. Water temperatures dropped from 22 to 18 degrees from the lower reach to the upper reach, probably due to contribution by springs. The water was cooler in Pua‘aka‘a Stream tributary than in the main channel of Kopili‘ula Stream, likely as a result of the higher stream flow.

The native shrimp, **‘ōpae kala‘ole** (*Atyoida bisulcata*), was only observed in the upper reaches. The native goby, **‘o‘opu nōpili** (*Sicyopterus stimpsoni*) was observed in the lower and middle reaches probably limited by the steep waterfall and decreased stream flow. **‘o‘opu nākea** (*Awaous guamensis*) and **hīhīwai** (*Neritina granosa*) were also mostly observed in the lower and middle reaches. The native goby, **‘o‘opu alamo‘o** (*Lentipes concolor*) was observed in the lower and upper reaches.

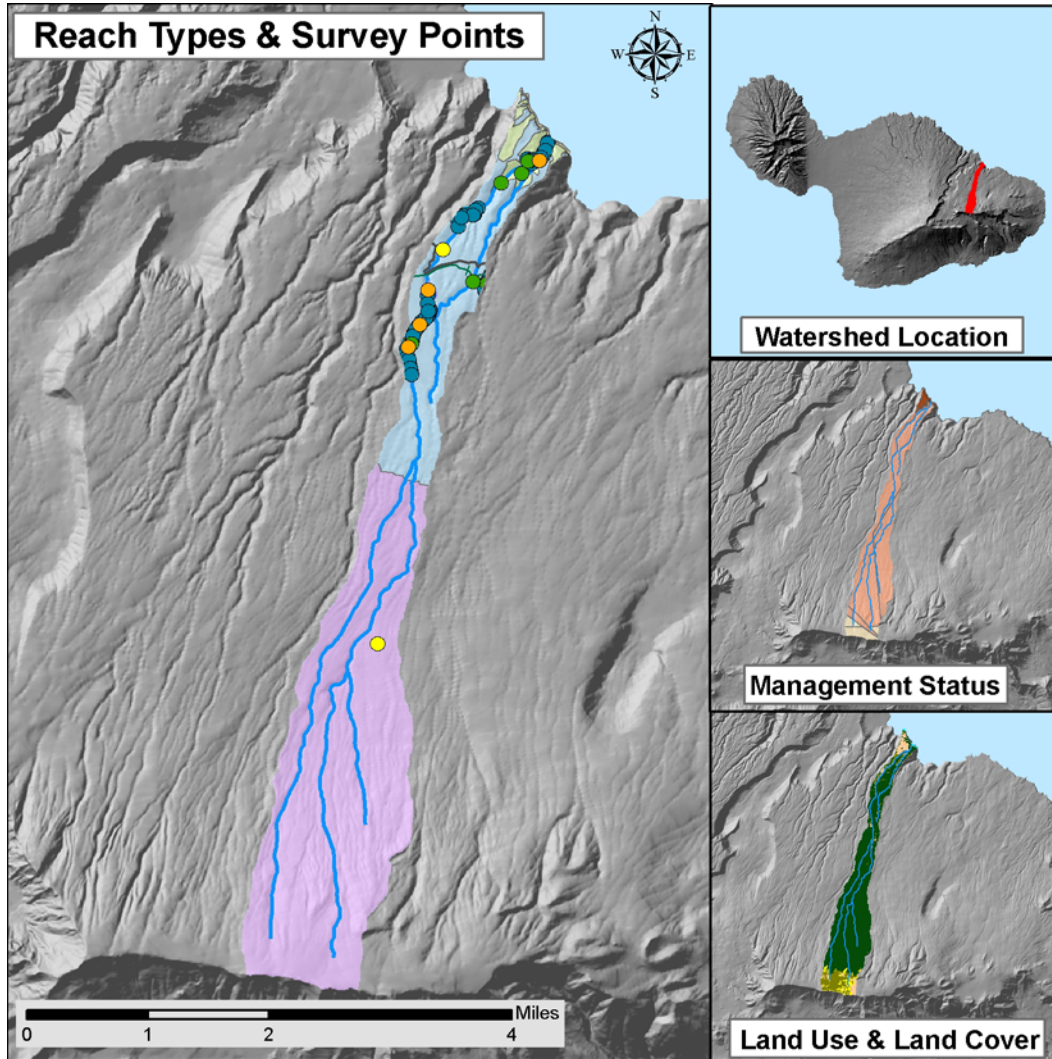
In the lowest sections below the first major waterfalls, Kopili‘ula Stream had a range of native animals with both adults and juveniles present. The sites had good depths ranging from 10 to 36 inches and were characterized by gravel, cobble, and boulder substrates. In the middle section of the stream below Hāna Highway and the stream diversion, the stream was typically composed of boulder or bedrock substrates with numerous pools with water depths greater than 20 inches. *L. concolor* adults and juveniles were present in decent numbers as were *A. bisulcata*. One adult *A. guamensis* was observed. Clearly habitat and migration routes for both fish and crustaceans exist in this section of the stream. In the upper section, above Hāna Highway and the stream diversion, only *A. bisulcata* were observed.

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Section 2: Watershed Atlas

DAR Watershed Code: 64017

Kopili‘ula, Maui



Watershed Features

Kopili‘ula watershed occurs on the island of Maui. The Hawaiian meaning of the name is unknown. The area of the watershed is 4.8 square mi (12.4 square km), with maximum elevation of 8323 ft (2537 m). The watershed's DAR cluster code is 2, meaning that the watershed is small, steep in the upper watershed, and with little embayment. The percent of watershed in the different land use districts is as follows: 0% agricultural, 100% 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	5.7	89.8	0.0	0.0	1.9	2.7

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

Permanent Biodiversity <u>Protection</u>	Managed for Multiple <u>Uses</u>	Protected but <u>Unmanaged</u>	<u>Unprotected</u>
7.6	89.8	0.0	2.7

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	0.1	0.00	0.01
Cultivated	0.0	0.00	0.00
Grassland	4.9	0.23	0.61
Scrub/Shrub	9.8	0.47	1.21
Evergreen Forest	82.1	3.93	10.19
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	0.14	0.35
Unconsolidated Shoreline	0.2	0.01	0.03
Water	0.1	0.01	0.01
Unclassified	0.0	0.00	0.00

Stream Features

Kopili‘ula is a perennial stream. Total stream length is 15.8 mi (25.5 km). The terminal stream order is 2.

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

<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
0.0	1.7	5.3	31.6	61.4

The following stream(s) occur in the watershed:
Kopili‘ula

Biotic Sampling Effort

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

1962	1975	1993	1995	1998	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>
Damselfly Surveys	0	0	0	4	1
DAR General Surveys	0	1	0	0	0
DAR Point Quadrat	0	10	5	50	0
HDFG	0	1	0	3	0
Published Report	0	0	2	3	0

Biota Information

Species List

Native Species

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

Introduced Species

Amphibians	<i>Rana rugosa</i>
Crustaceans	<i>Macrobrachium lar</i>
Snails	Physid sp.

Native Species

Insects	<i>Anax junius</i>
	Anisoptera sp.
	<i>Megalagrion blackburni</i>
	<i>Megalagrion calliphya</i>
	<i>Megalagrion hawaiiense</i>
	<i>Megalagrion nigrohamatum nigrohamatum</i>
	<i>Megalagrion</i> sp.
	<i>Telmatogeton</i> sp.

Introduced Species

Insects	<i>Cheumatopsyche analis</i>
	Chironomid sp.

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

<u>Scientific Name</u>	<u>Status</u>	<u>Minimum Size</u>	<u>Maximum Size</u>	<u>Average Size</u>
<i>Rana rugosa</i>	Introduced	1.75	3	2.5
<i>Atyoida bisulcata</i>	Endemic	0.65	2	1.3
<i>Macrobrachium lar</i>	Introduced	2	4	3.3
<i>Eleotris sandwicensis</i>	Endemic	1.5	4	2.4
<i>Kuhlia xenura</i>	Endemic	1.25	3	1.9
<i>Lentipes concolor</i>	Endemic	0.75	3.5	1.9
<i>Sicyopterus stimpsoni</i>	Endemic	1	4.5	1.8
<i>Awaous guamensis</i>	Indigenous	0.875	6	2.9
<i>Telmatogeton</i> sp.	Indigenous	0.5	0.75	0.7

Anisoptera sp.	Unknown	1	2	1.5
<i>Neritina granosa</i>	Endemic	1	2	1.6
<i>Heteromeyenia baileyi</i>	Indigenous	12	12	12.0

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				15.1	
<i>Eleotris sandwicensis</i>	Endemic		2.3			
<i>Kuhlia xenura</i>	Endemic		4.31			
<i>Lentipes concolor</i>	Endemic		2.59		1.28	
<i>Neritina granosa</i>	Endemic		6.32	2.21		
<i>Sicyopterus stimpsoni</i>	Endemic		4.02	9.94		
<i>Awaous guamensis</i>	Indigenous		3.73	11.0	0.06	
<i>Heteromeyenia baileyi</i>	Indigenous				0.06	
<i>Telmatogeton</i> sp.	Indigenous				0.06	
<i>Macrobrachium lar</i>	Introduced		0.29	8.83	0.17	
<i>Rana rugosa</i>	Introduced				0.17	
Anisoptera sp.	Unknown				0.12	

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	P		
<i>Kuhlia xenura</i>	Endemic		P			
<i>Lentipes concolor</i>	Endemic		P	P	P	
<i>Sicyopterus stimpsoni</i>	Endemic		P	P	P	
<i>Megalagrion blackburni</i>	Endemic				P	
<i>Megalagrion calliphya</i>	Endemic				P	
<i>Megalagrion hawaiiense</i>	Endemic					P
<i>Megalagrion nigrohamatum</i> <i>nigrohamatum</i>	Endemic				P	
<i>Megalagrion</i> sp.	Endemic		P		P	
<i>Neritina granosa</i>	Endemic		P	P	P	
<i>Awaous guamensis</i>	Indigenous		P	P	P	
Gobiid sp.	Indigenous		P		P	
<i>Kuhlia</i> sp.	Indigenous			P		
<i>Anax junius</i>	Indigenous				P	
<i>Telmatogeton</i> sp.	Indigenous				P	
<i>Heteromeyenia baileyi</i>	Indigenous				P	

<i>Rana rugosa</i>	Introduced			P
<i>Macrobrachium lar</i>	Introduced	P	P	P
<i>Cheumatopsyche analis</i>	Introduced			P
Chironomid sp.	Introduced	P		P
Physid sp.	Introduced			P
Anisoptera sp.	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): Moderate

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

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

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

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

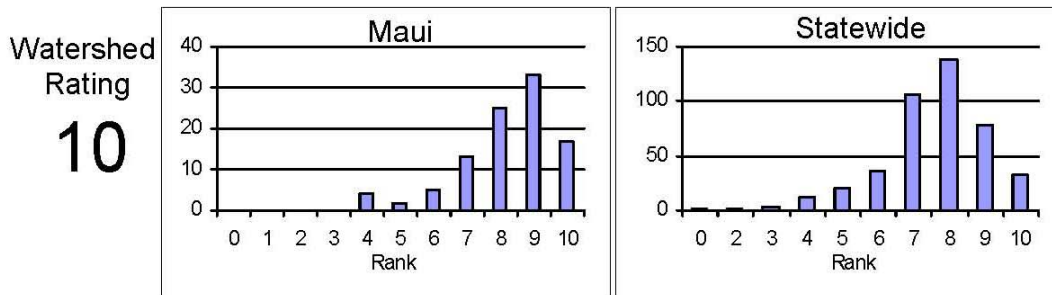
Native Insect Diversity <u>> 19 spp.</u>	Native Macrofauna <u>Diversity > 5 spp.</u>	Absence of Priority 1 <u>Introduced</u>
No	Yes	No
Abundance of Any <u>Native Species</u>	Presence of Candidate <u>Endangered Species</u>	Endangered Newcomb's <u>Snail Habitat</u>
No	No	No

CURRENT WATERSHED AND STREAM RATINGS

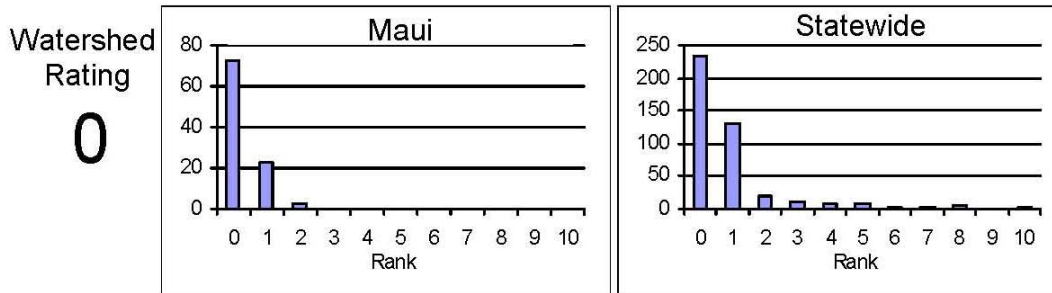
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding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

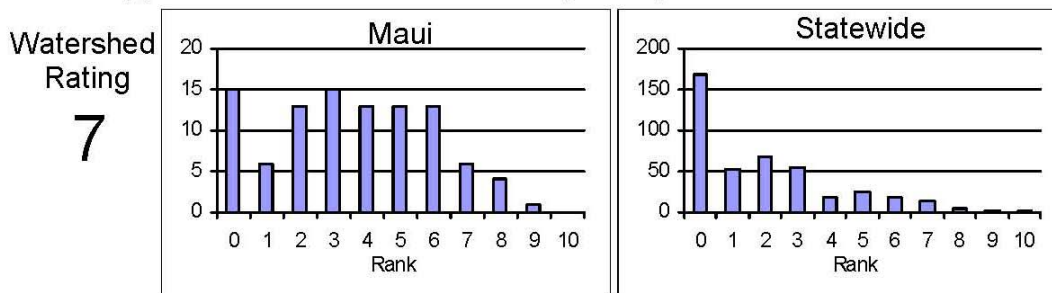
Land Cover Rating: Rating is based on a scoring system where in general forested lands score positively and developed lands score negatively.



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

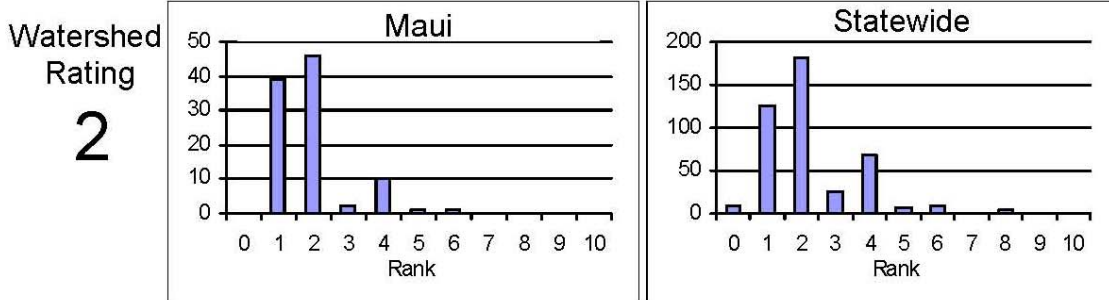


Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.

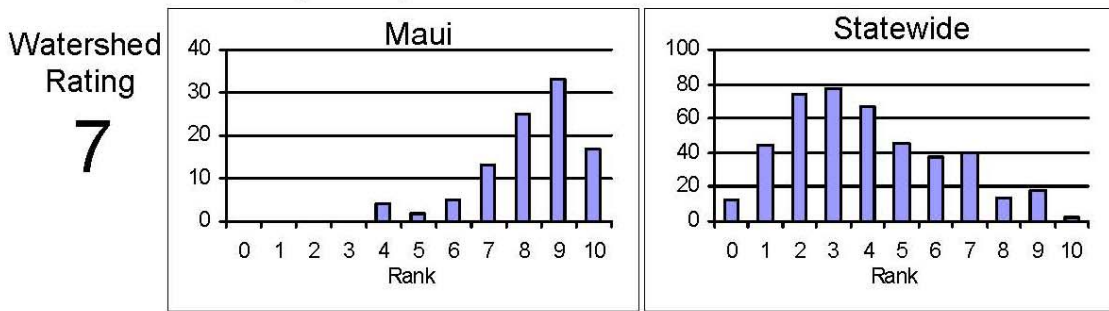


WATERSHED RATING (Cont): Kopili'ula, Maui

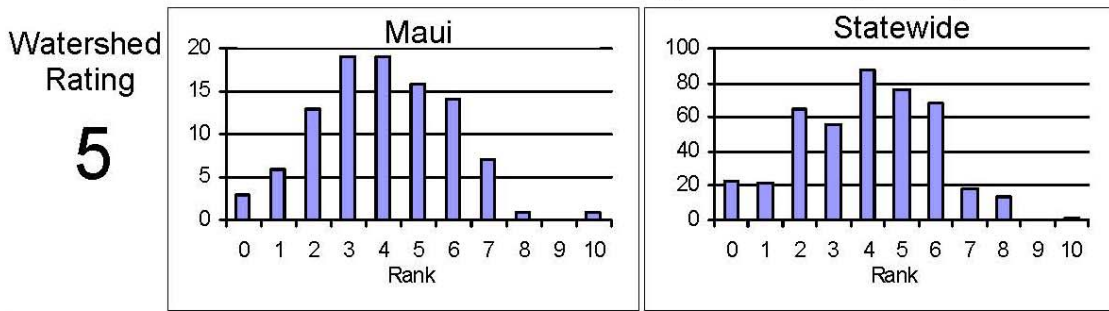
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.



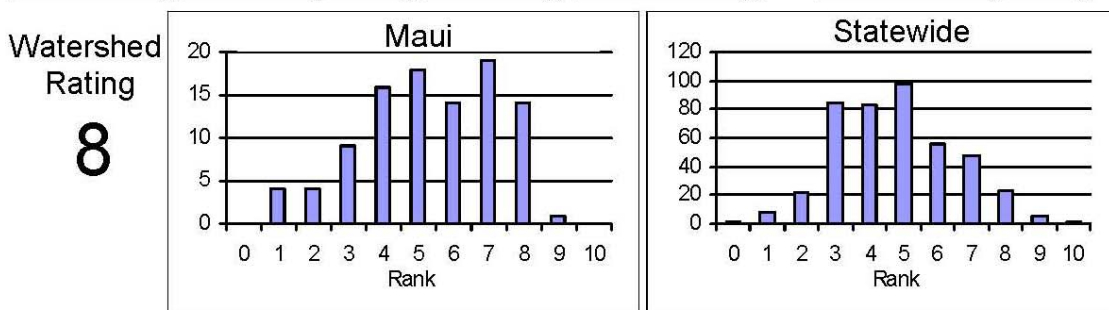
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.



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.



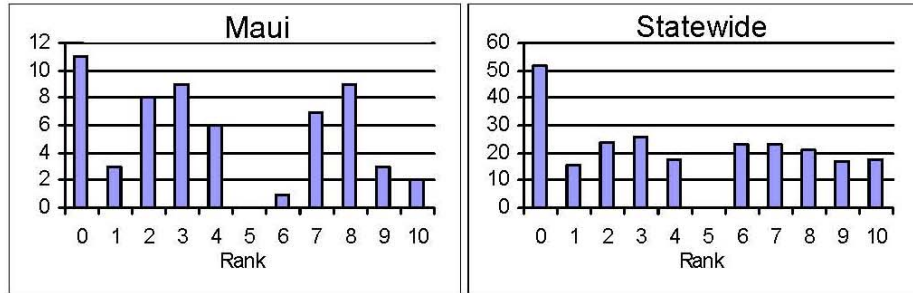
Total Watershed Rating: Rating is based on combination of Land Cover Rating, Shallow Waters Rating, Stewardship Rating, Size Rating, Wetness Rating, and Reach Diversity Rating.



BIOLOGICAL RATING: Kopili'ula, Maui

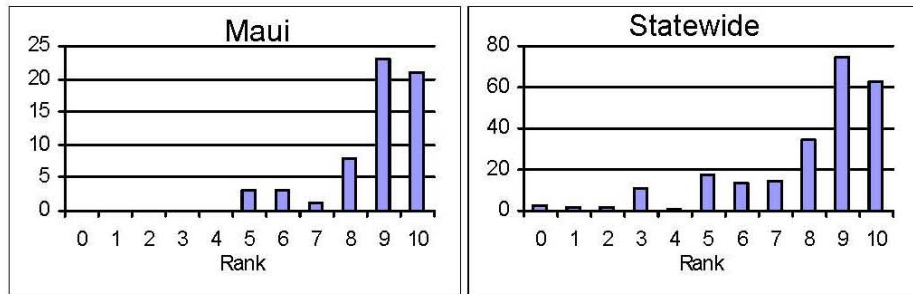
Native Species Rating: Rating is based on the number of native species observed in the watershed.

Stream Rating
8



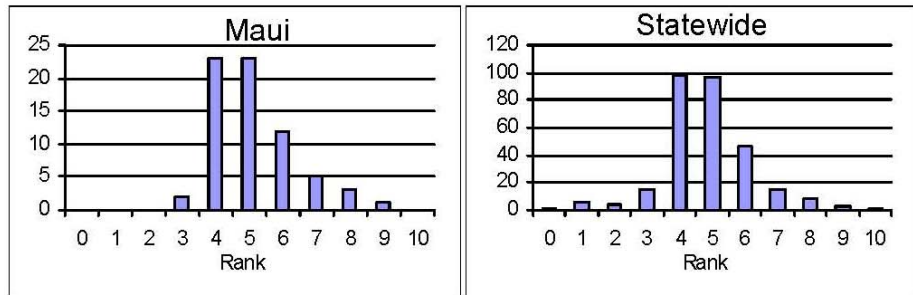
Introduced Genera Rating: Rating is based on the number of introduced genera observed in the watershed.

Stream Rating
9



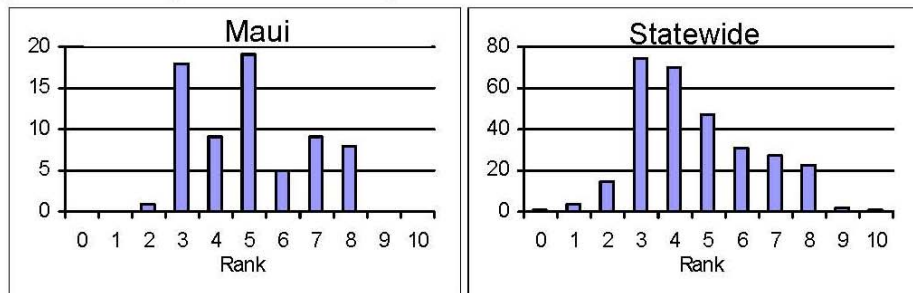
All Species' Score Rating: Rating is based on the Hawaii Stream Assessment scoring system where native species score positively and introduced species score negatively.

Stream Rating
6



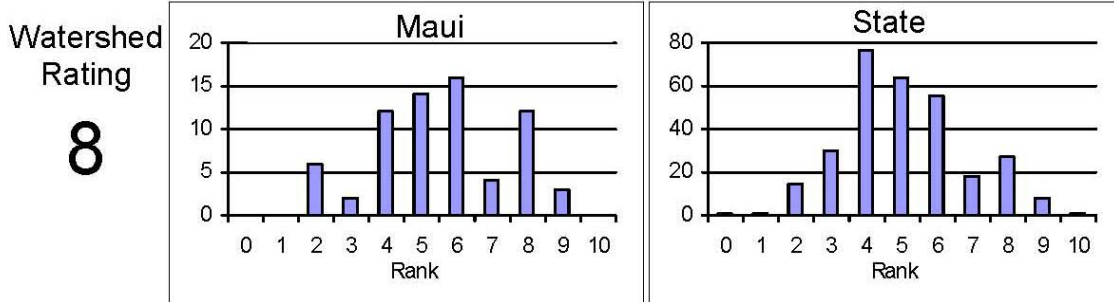
Total Biological Rating: Rating is the combination of the Native Species Rating, Introduced Genera Rating, and the All Species' Score Rating.

Stream Rating
7



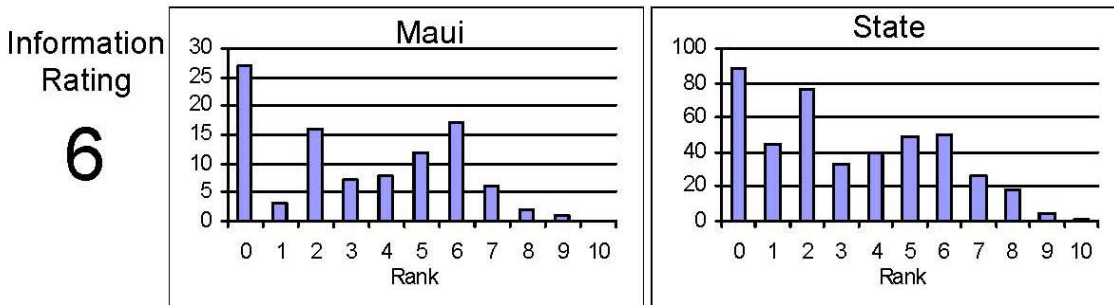
OVERALL RATING: Kopili'ula, Maui

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



RATING STRENGTH: Kopili'ula, 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.



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Section 3: DAR Point Quadrat Report

For Surveys from 1/21/2003 to 5/14/2009

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:

Kopili‘ula (ID: 64017), Ke‘anae, Maui

Surveys were conducted by these personnel:

Hau, Skippy
Higashi, Glenn
Kuamo‘o, Darrell
Nishimoto, Robert
Nishiura, Lance
Sakihara, Troy
Shimoda, Troy
Shindo, Tim

Results

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

Reach	Total number of surveys
Estuary	0
Lower	10
Middle	5
Upper	50
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	7	0	0	1	3	2	1	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	0	4	34	15	44	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	22.01	0.097	8708	7.927

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

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>
Crustacean	Introduced	<i>Macrobrachium lar</i>
Fish	Endemic	<i>Eleotris sandwicensis</i>
Fish	Endemic	<i>Kuhlia xenura</i>
Fish	Endemic	<i>Lentipes concolor</i>
Fish	Endemic	<i>Sicyopterus stimpsoni</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>
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Lower	0.26	1
Fish	Endemic	<i>Eleotris sandwicensis</i>	Lower	2.12	8
Fish	Endemic	<i>Kuhlia xenura</i>	Lower	3.97	15
Fish	Endemic	<i>Lentipes concolor</i>	Lower	2.38	9
Fish	Endemic	<i>Sicyopterus stimpsoni</i>	Lower	5.29	20
Fish	Indigenous	<i>Awaous guamensis</i>	Lower	3.97	15
Snails	Endemic	<i>Neritina granosa</i>	Lower	5.82	22

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	5	1	0	1	2	1	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	5	19	14	62	0

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	21.842	0.092	8.822	8.25

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	Indigenous	<i>Awaous guamensis</i>
Fish	Endemic	<i>Sicyopterus stimpsoni</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>
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Middle	6.09	8
Fish	Indigenous	<i>Awaous guamensis</i>	Middle	7.61	10
Fish	Endemic	<i>Sicyopterus stimpsoni</i>	Middle	15.99	21
Snails	Endemic	<i>Neritina granosa</i>	Middle	3.05	4

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	46	6	3	4	17	13	3	0	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	2	11	8	29	48

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	18.363	.07	7.937	7.734

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>
Crustacean	Endemic	<i>Atyoida bisulcata</i>
Crustacean	Introduced	<i>Macrobrachium lar</i>
Fish	Indigenous	<i>Awaous guamensis</i>
Fish	Endemic	<i>Lentipes concolor</i>
Sponge	Indigenous	<i>Heteromeyenia baileyi</i>
Insect	Indigenous	<i>Telmatogeton</i> sp.
Insect	Unknown	Anisoptera sp.
Snail	Introduced	Physid sp.

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

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg. Density</u>	<u>Total # observed</u>
Crustaceans	Endemic	<i>Atyoida bisulcata</i>	Upper	12.78	247
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Upper	0.16	3
Fish	Indigenous	<i>Awaous guamensis</i>	Upper	0.05	1
Fish	Endemic	<i>Lentipes concolor</i>	Upper	0.36	7
Sponges	Indigenous	<i>Heteromeyenia baileyi</i>	Upper	0.05	1
Insects	Indigenous	<i>Telmatogeton</i> sp.	Upper	0.16	3
Insects	Unknown	Anisoptera sp.	Upper	0.1	2
Snails	Introduced	Physid sp.	Upper	0.05	1

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

<u>Latitude</u>	<u>Longitude</u>	<u>Total CFS</u>	<u>MGD</u>
20.83005	-156.12045	1.35	0.87

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

Latitude	Longitude	Total CFS	MGD
20.82446	-156.12726	0.32	0.2
20.82227	-156.12989	0.14	0.09
20.81413	156.13391	4.62	2.98

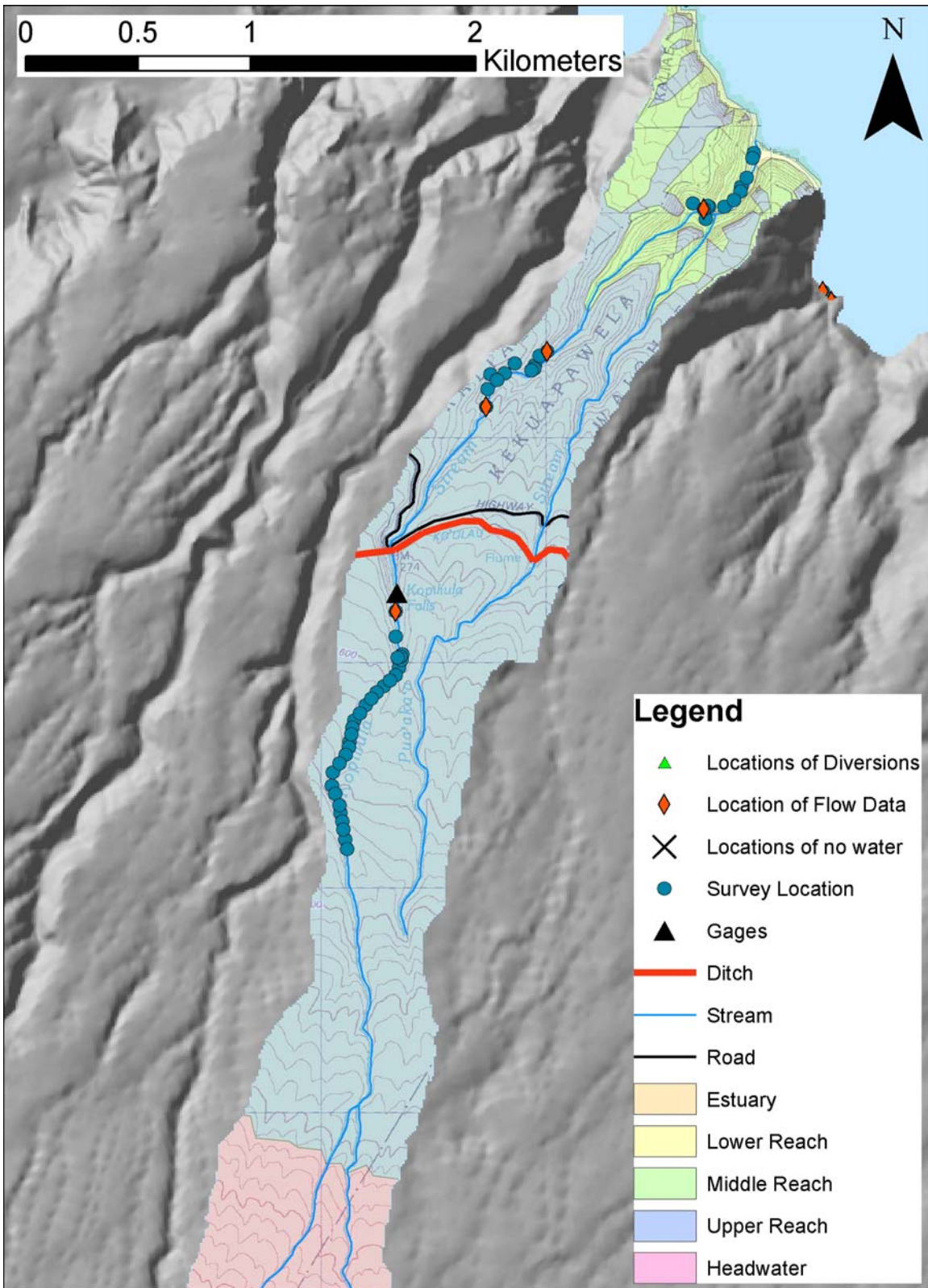


Figure 3-2. Locations of diversion, flow data and no flow surveys conducted in Kopili'ula Stream.

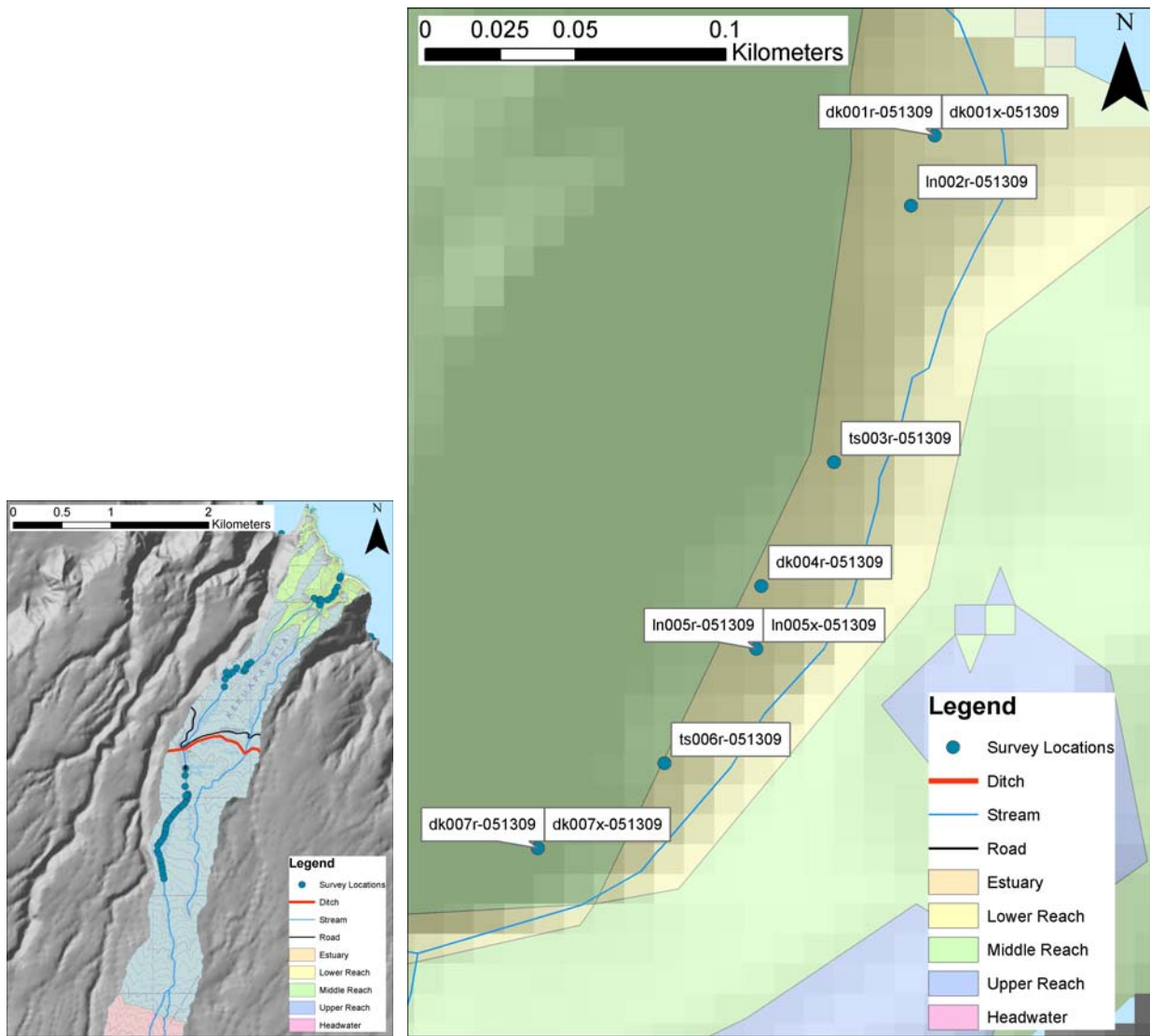


Figure 3-3. Point quadrat survey locations in the lower reach of Kopili‘ula Stream.

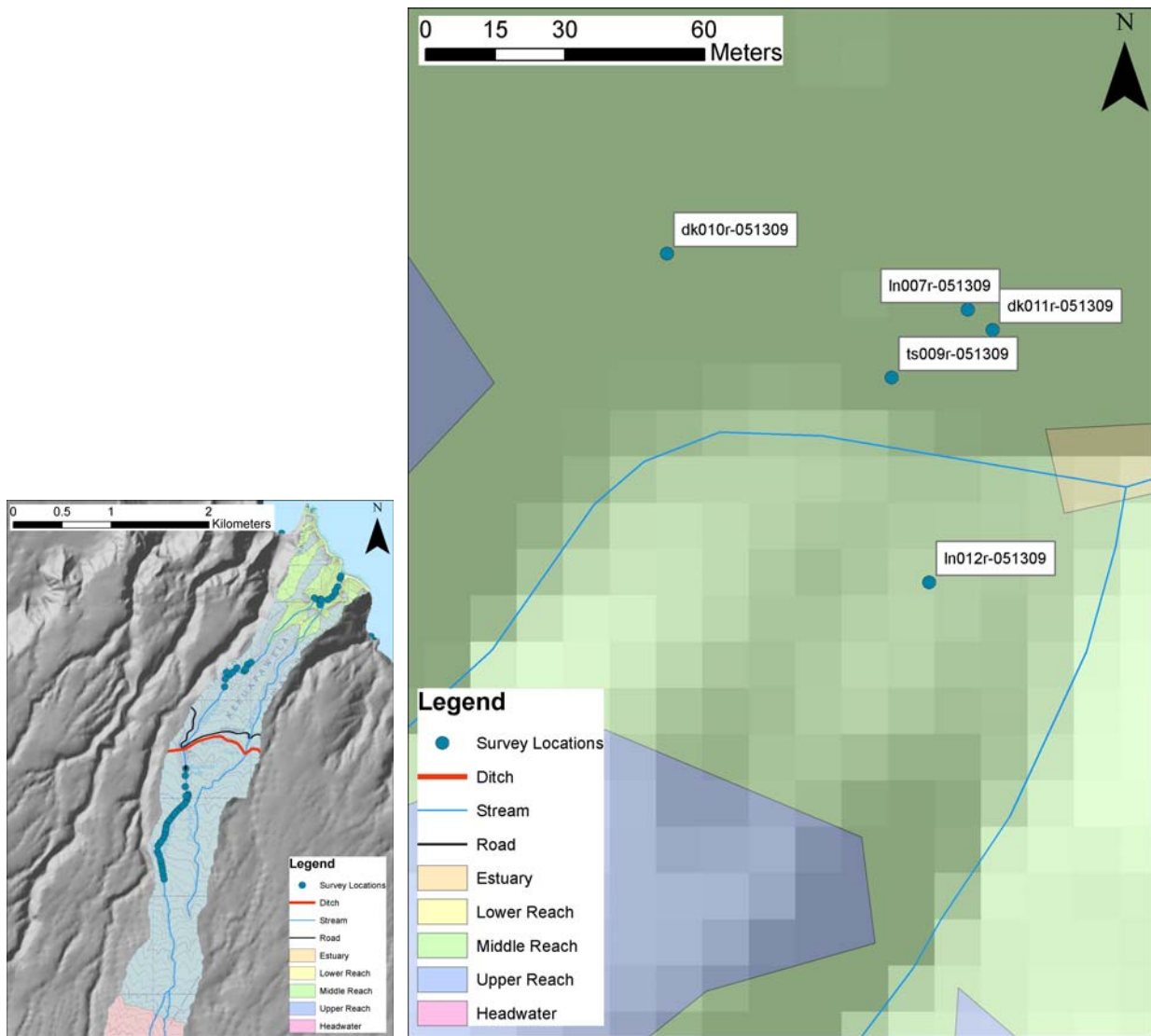


Figure 3-4. Point quadrat survey locations in the middle reach of Kopili'ula Stream.

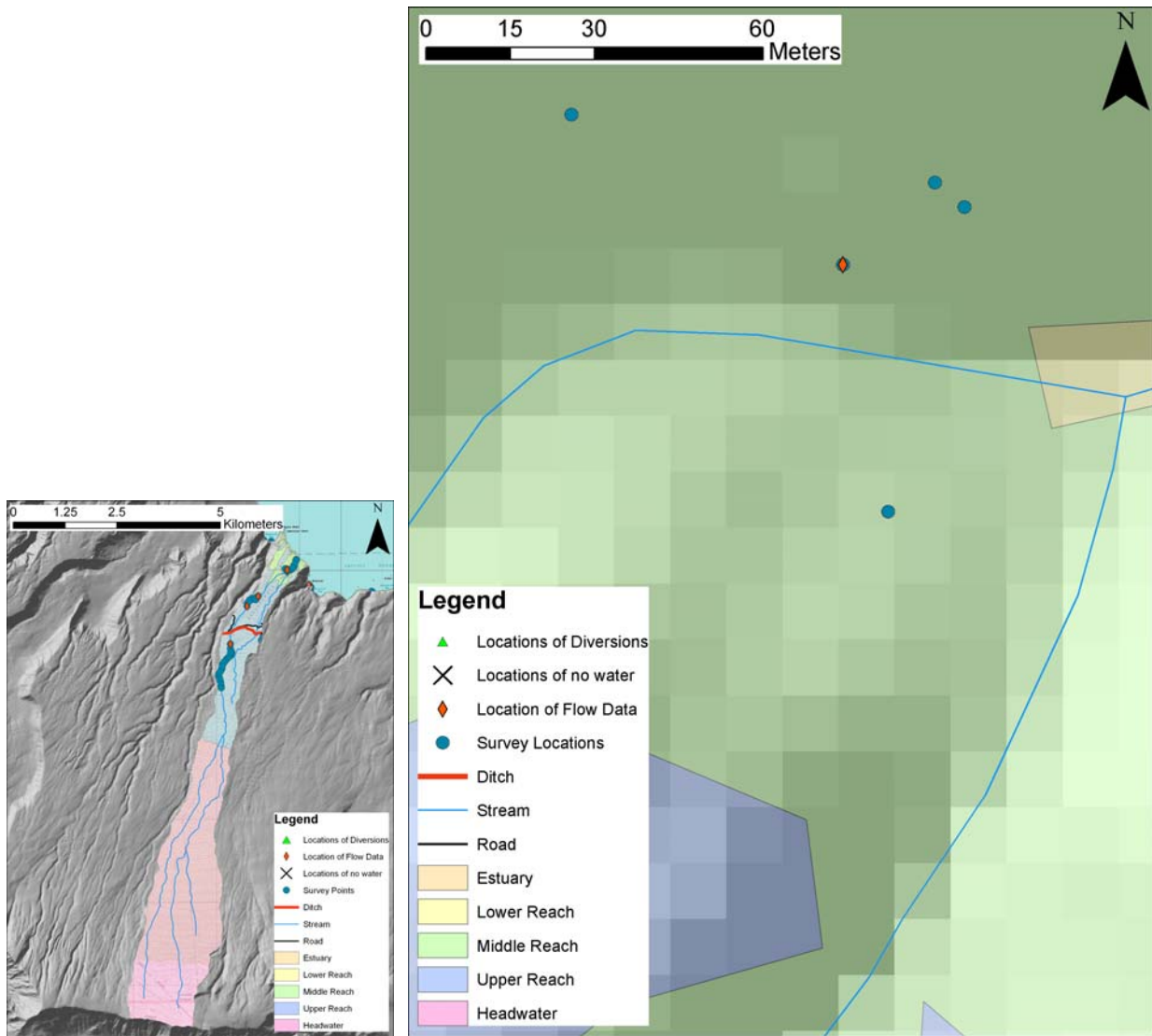


Figure 3-5. Locations of surveys of diversions, flow measurements, and no water conditions in the middle reach of Kopili'ula Stream.

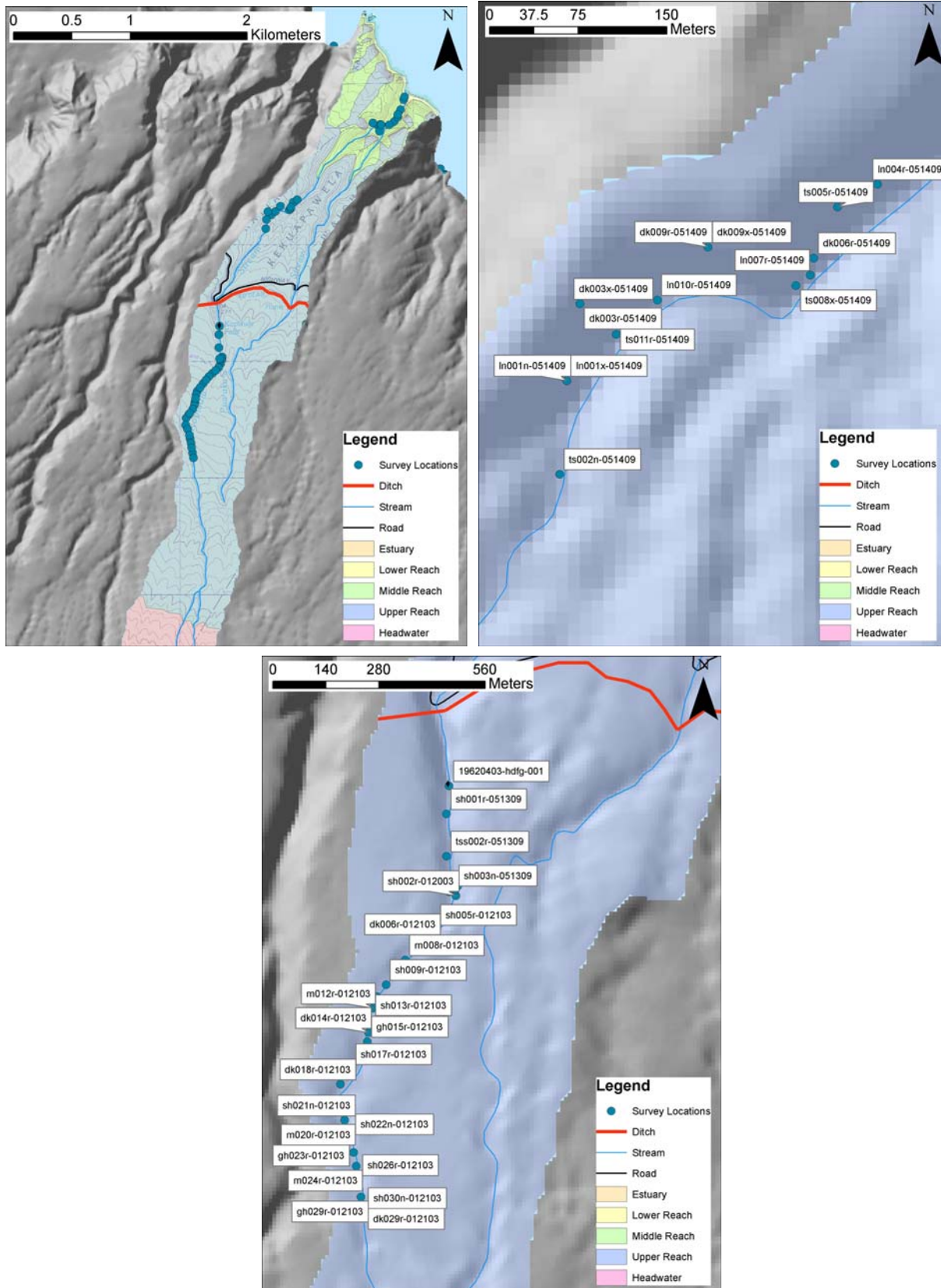


Figure 3-6. Point quadrat survey locations with SBN in the upper reach of Kopili'ula Stream.

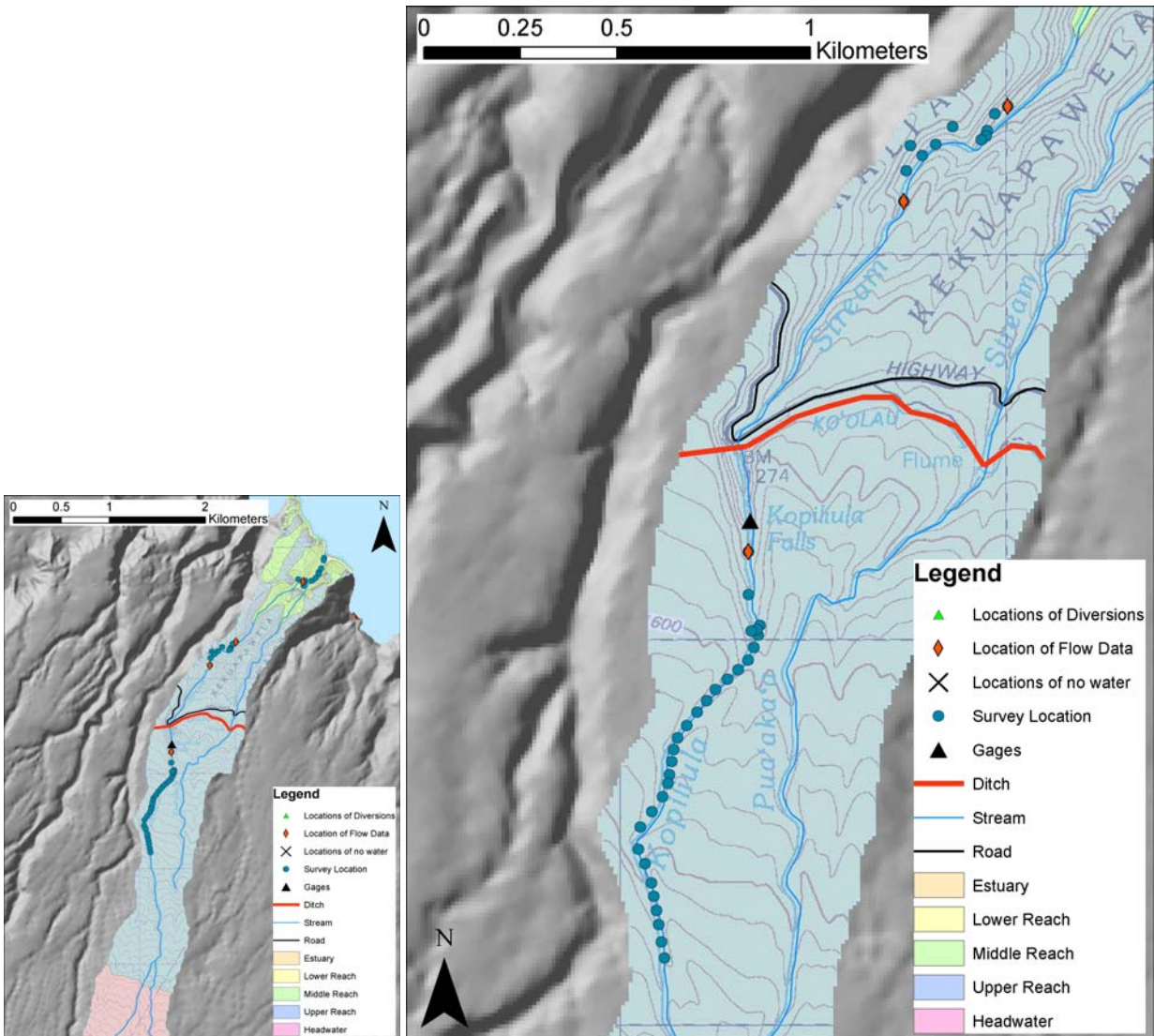


Figure 3-7. Locations of surveys of diversions, flow measurements, and no water conditions in the upper reach of Kopili‘ula Stream.

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Section 4: DAR Estuary Survey Report

For Surveys Conducted on: 5/13/2009

Introduction

This is a report of the Hawai'i Division of Aquatic Resources estuary survey. Trained biologists and technicians survey a series of randomly located points in a stream to generate an assessment of species and habitat in the stream

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 to the estuary. Any unidentifiable specimen was kept and preserved in 5% formalin for identification. Any unusual observations were also documented. This process was repeated along the shoreline until the extent of the estuary was surveyed or if physical barriers that restricted continued surveying were reached (i.e., cliffs, hazardous terrain or high surf).

The Estuary Sampling Site, Kopili'ula, is located in the region of Ke'anae, Maui. The watershed (and watershed ID), region, and island surveyed in this report

Kopili'ula (ID: 64017), Ke'anae, Maui

Surveys were completed by these DAR staff:

Kuamo'o, Darrell
Nishiura, Lance
Shimoda, Troy

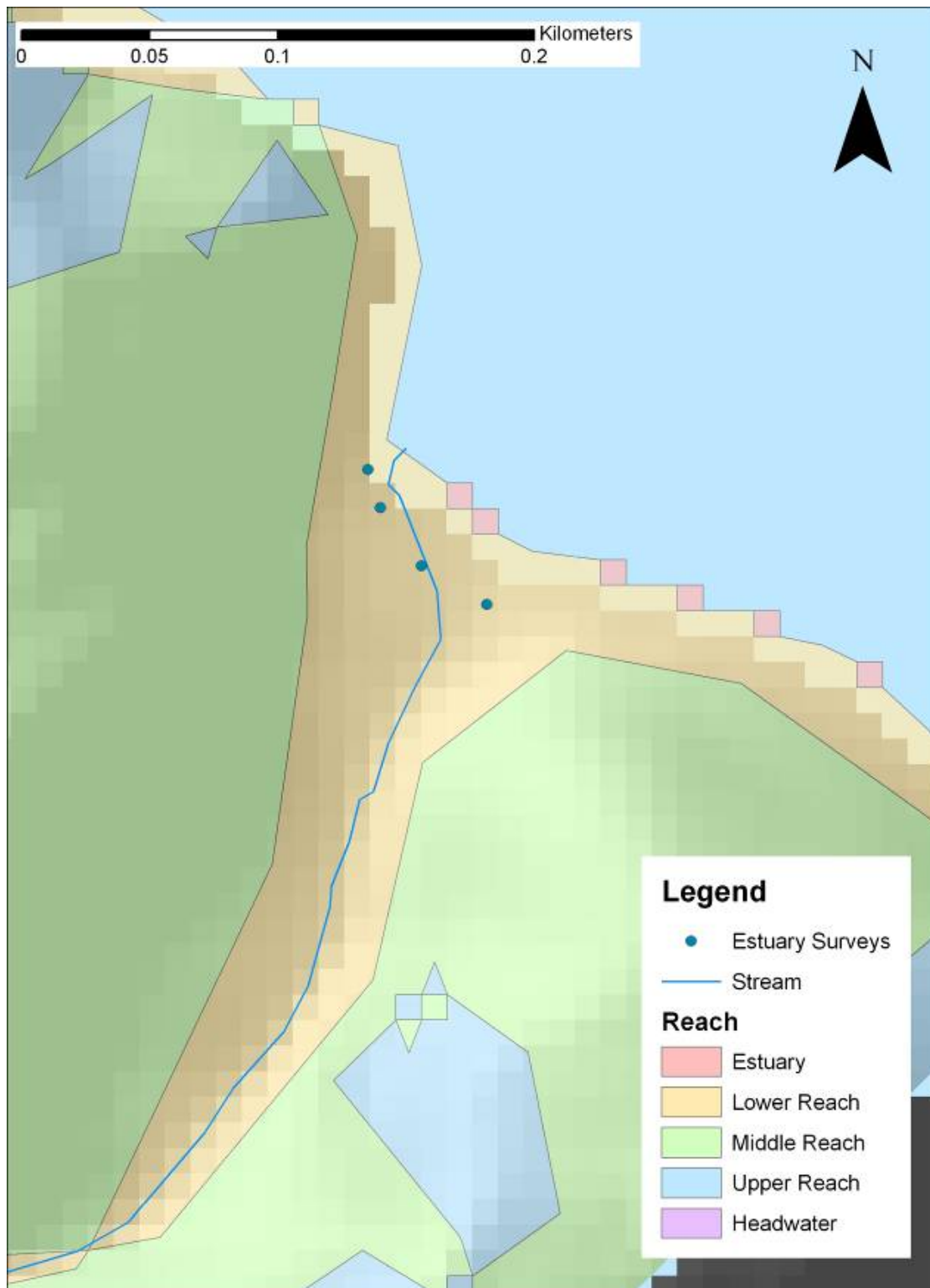


Figure 4-1. Location of estuary surveys conducted in Kopili'ula Stream.

Results

Table 4-1. Summary of estuary classification and habitat description in Kopili‘ula

Location	Location ID	Estuary Status	Estuary Type	Reach	Habitat Type(s)
Kopili‘ula	16	Natural	Coastal Embayment	Lower	Rock Rubble

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

Avg Detritus	Avg Sediment	Avg Sand	Avg Gravel	Avg Cobble
0	0	0	0	56
Avg Boulder	Avg Bedrock	Avg Emergent Veg	Avg Submergent Veg	Avg Coral
44	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 Kopili‘ula.

Location	Location ID	Depth min (cm)	Depth max (cm)	Depth avg (cm)	Depth Std dev. (cm)
Kopili‘ula	16	38	62	56	6.27

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

Location	Location ID	DO min (mg/L)	DO max (mg/L)	DO avg. (mg/L)	DO Std. Dev. (mg/L)
Kopili‘ula	16	4.37	5.89	5.45	0.31

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

Location	Location ID	pH min	pH max	pH avg.	pH Std. Dev.
Kopili‘ula	16	7.86	8.09	7.90	0.08

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

Location	Location ID	Salinity min (ppt)	Salinity max (ppt)	Salinity avg. (ppt)	Salinity Std. Dev. (ppt)
Kopili‘ula	16	20.21	34.13	31.51	3.61

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

Location	Location ID	Temp min (° C)	Temp max (° C)	Temp avg. (° C)	Temp Std. Dev. (° C)
Kopili‘ula	16	22.61	23.69	23.26	0.24

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

Location	Location ID	Number of Surveys	Species	Category	Status	# of animals
Kopili‘ula	16	4	<i>Iso hawaiiensis</i>	Fish	Endemic	9

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

Species	Category	# of animals	Max(mm)	Min(mm)	Avg(mm)	Std. Dev.
<i>Iso hawaiiensis</i>	Fish	9	35	27	32	2.44

Summary

Estuary Surveys were conducted in the estuary reach of Kopili‘ula. A total of 80m of shoreline was surveyed in 1 discrete section. Only one species of fish captured. Kopili‘ula Stream mouth is enclosed by a small embayment. At the time of the survey (5/13/09) the stream mouth was closed by a cobble berm, however during helicopter reconnaissance of the stream mouth was open to the ocean (4/8/2009) probably due to heavy rain events in March and April based on opinion. Heavy surf in May may have closed it off before the survey.

Low salinity along the shoreline in area where stream mouth is closed suggesting that the stream is still flowing into the ocean, through the cobble berm although no surface connection on the surface. Higher salinity was noted further down the beach away from the mouth.

Species observed in Kopili‘ula Estuary:

Native Species

Fish *Iso hawaiiensis*

Section 5: Photographs taken during stream surveys

Estuary

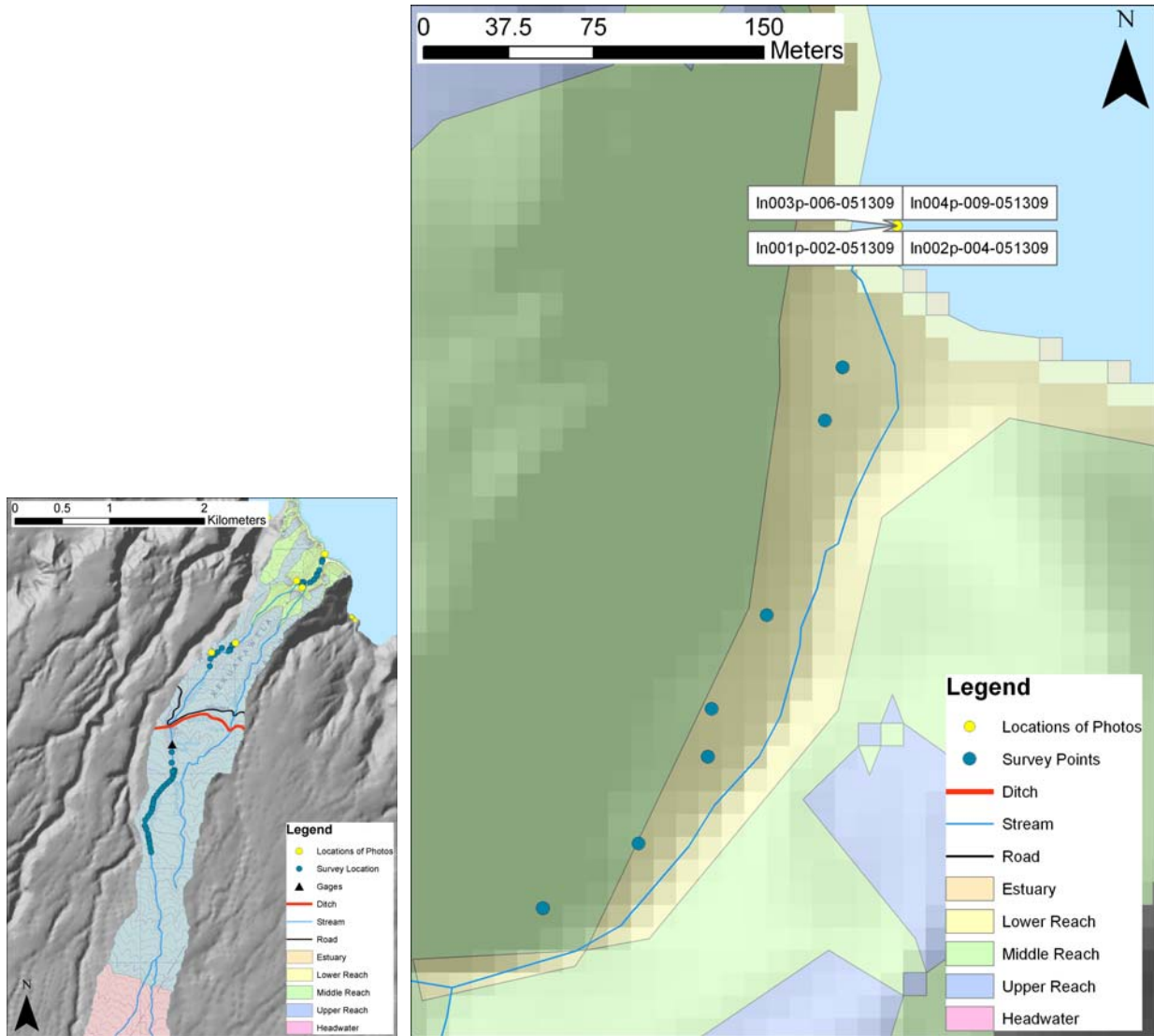


Figure 5-1. Photo locations in the estuary and lower reach of Kopili'ula Stream.



Figure 5-2. Aerial photo of Kopili'ula Stream mouth. The stream mouth was closed by a natural cobble berm. (5/13/2009; Tributary name: Kopili'ula (64017001); PBN: sh64017001p-008-051309); Photo by: Hau, S.).



Figure 5-3. Kopili'ula stream entering the ocean. (4/8/2009; Tributary name: Kopili'ula (64017001); PBN: dk64017001p-005-040809; Photo by: Kuamo'o, D.).



Figure 5-4. DAR surveyor collecting samples in white water at survey site 3. (5/13/2009; Tributary name: Kopili'ula (64017001); PBN: In003p-006-051309; Surveyor: Nishiura, L.; SBN: In003e-051309; Lat. (DD): 20.83283, Long. (DD): -156.11803).



Figure 5-5. Hawaiian surf fish (*Iso hawaiiensis*) on a measuring board collected at survey site 4. (5/13/2009; Tributary name: Kopili'ula (64017001); PBN: In004p-009-051309; Surveyor: Nishiura, L.; SBN: In004e-051309; Lat. (DD): 20.83283, Long. (DD): -156.11803).



Figure 5-6. Photo shows the mouth of the stream which is closed by the berm at survey site 2. (5/13/2009; Tributary name: Kopili'ula (64017001); PBN: In002p-005-051309; Surveyor: Nishiura, L.; SBN: In002e-051309; Lat. (DD): 20.83283, Long. (DD): -156.11803).



Figure 5-7. Photo showing closed stream mouth by cobble berm created by high surf at survey site 2. (5/13/2009; Tributary name: Kopili'ula (64017001); PBN: In002p-004-051309; Surveyor: Nishiura, L.; SBN: In002e-051309; Lat. (DD): 20.83283, Long. (DD): - 156.11803).



Figure 5-8. Photo of shoreline next to closed stream mouth at survey site 1. (5/13/2009; Tributary name: Kopili'ula (64017001); PBN: ln001p-002-051309; Surveyor: Nishiura, L.; SBN: ln001e-051309; Lat. (DD): 20.83283, Long. (DD): -156.11803).

Lower Reach

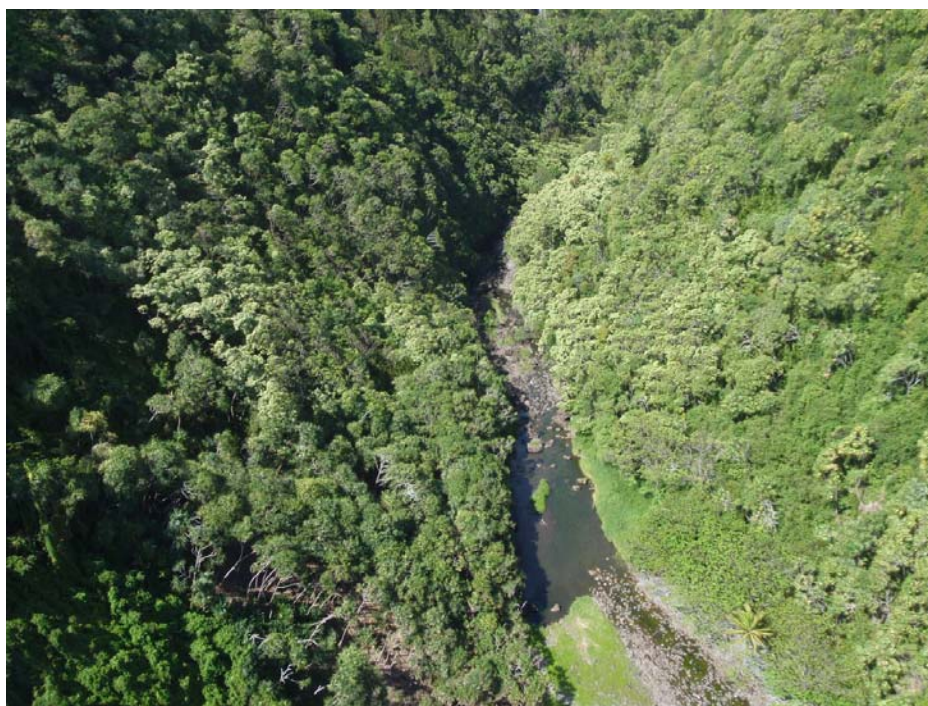


Figure 5-9. Aerial Photo of lower reach of Kopili'ula Stream. (5/13/2009; Tributary name: Kopili'ula (64017003); PBN: sh64017003p-009-051309; Photo by: Hau, S.



Figure 5-10. Photo taken from the estuary facing upstream towards the waterfall where survey site 12 was conducted. (5/13/2009; Tributary name: Pua'aka'a (64017002); PBN: In012p-029-051309; Surveyor: Nishiura, L.; Habitat type: Plunge Pool; SBN: In012r-051309; Lat. (DD): 20.82965, Long. (DD): -156.12038).



Figure 5-11. Aerial photograph showing waterfall on left tributary Pua'aka'a (64017002) encircled in red; (4/8/2009; Tributary name: Pua'aka'a (64017002); PBN: dk64017002p-006-049809); Photo by: Kuamo'o, D.

Middle Reach

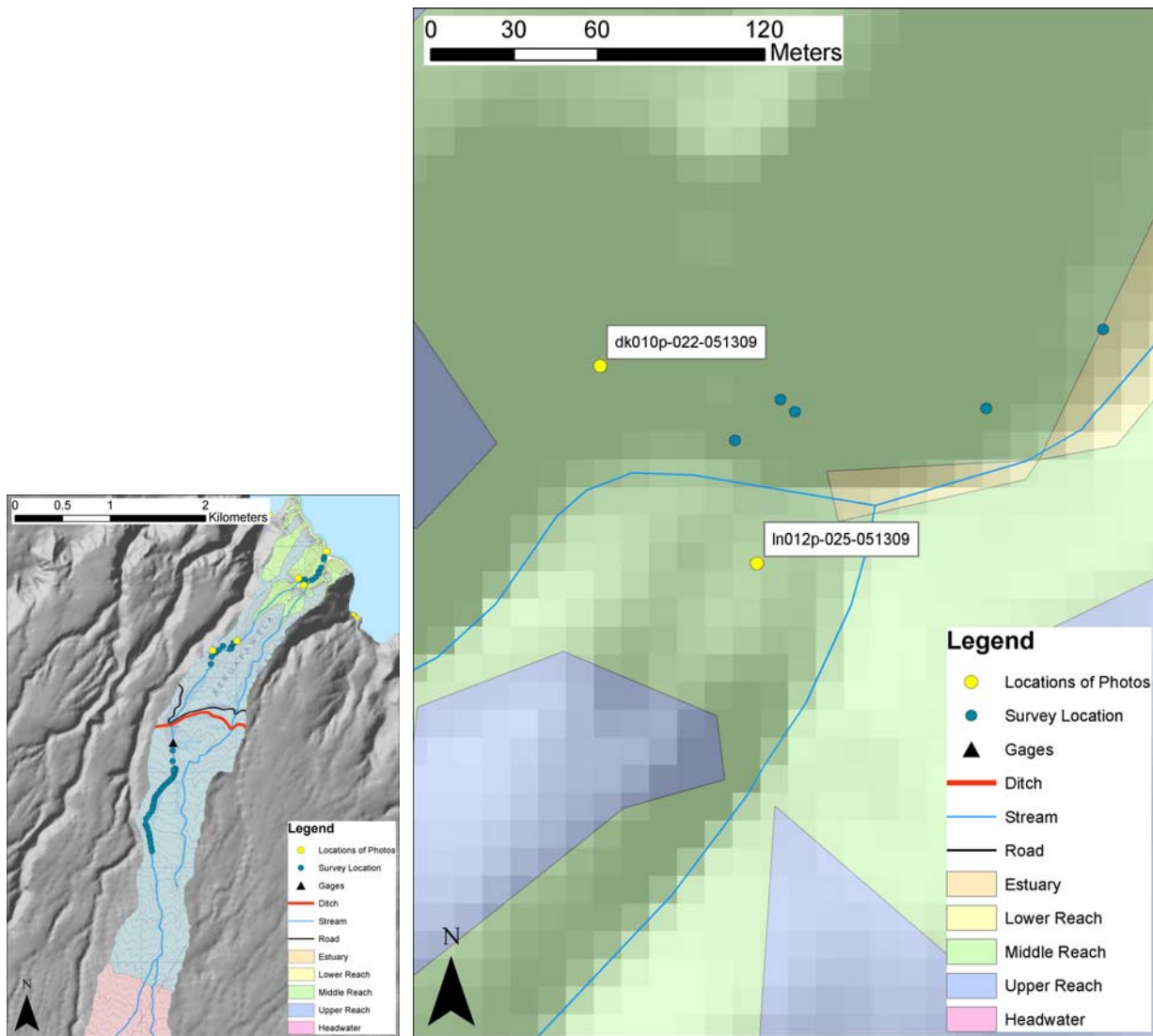


Figure 5-12. Photo locations in the middle reach of Kopili'ula Stream.

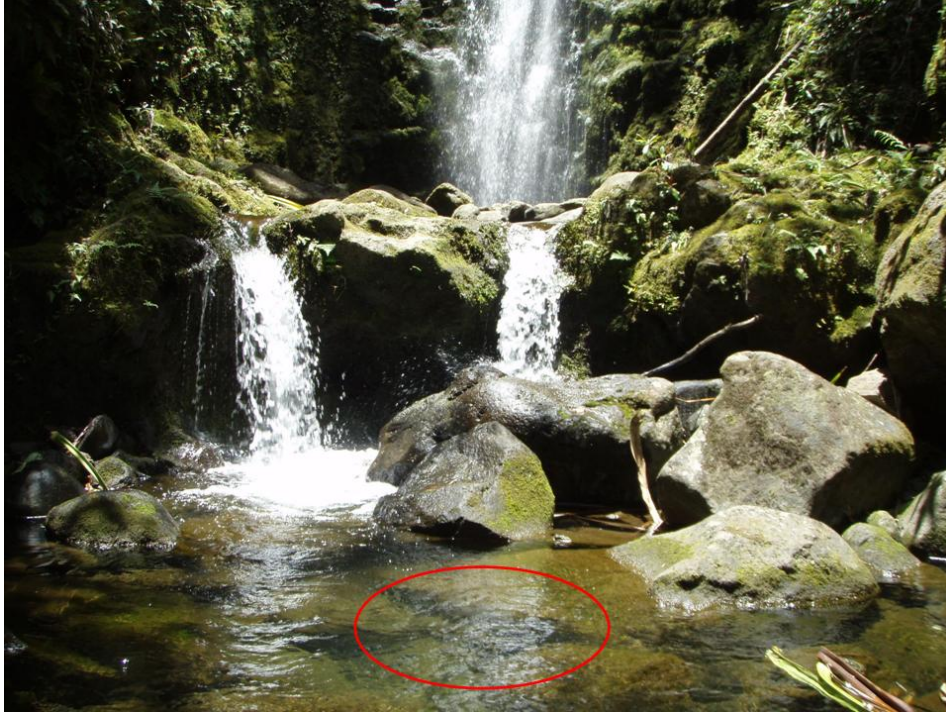


Figure 5-13. Photo shows survey site 12 and the upstream view. (5/13/2009; Tributary name: Pua'aka'a (64017002); PBN: ln012p-025-051309; Surveyor: Nishiura, L.; Habitat type: Plunge Pool; SBN: ln012r-051309; Lat. (DD): 20.82965, Long. (DD): -156.12038).



Figure 5-14. Aerial photograph of first waterfall on right tributary Kopili'ula (64017003); (4/8/2009; Tributary name: Kopili'ula (64017003); PBN: dk64017003p-007-049809); Photo by: Kuamo'o, D.).



Figure 5-15. Photo of plunge pool at survey site 10 in Kopili'ula Stream. Photo taken upstream. (5/13/2009; Tributary name: Kopili'ula (64017003); PBN: dk010p-022-051309; Surveyor: Kuamo'o, D.; Habitat type: Pool; SBN: dk010r-051309; Lat. (DD): 20.83030, Long. (DD): -156.12091).

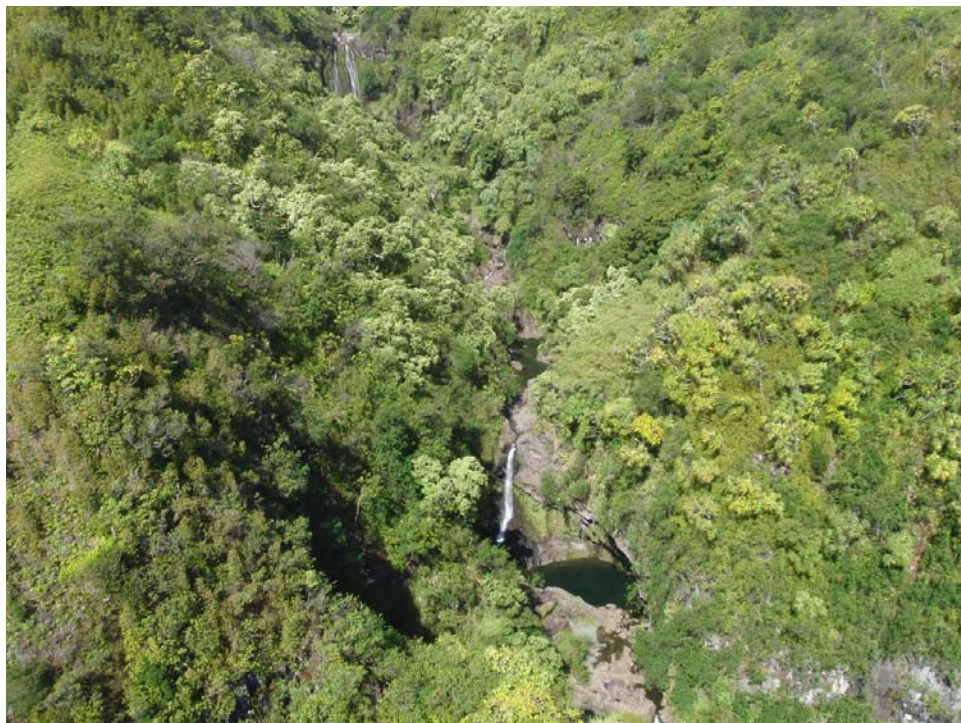


Figure 5-16. Aerial photo of middle reach of Kopili'ula Stream. (5/13/2009; Tributary name: Kopili'ula (64017003); PBN: sh64017003p-012-051309; Photo by: Hau, S.).



Figure 5-17. Aerial photo of Stream below Hāna Highway. Notice the low flow and the lack of white water. (5/13/2009; Tributary name: Kopili'ula (64017003); PBN: sh64017003p-018-051309; Photo by: Hau, S.; (Exact location unknown).

Upper Reach

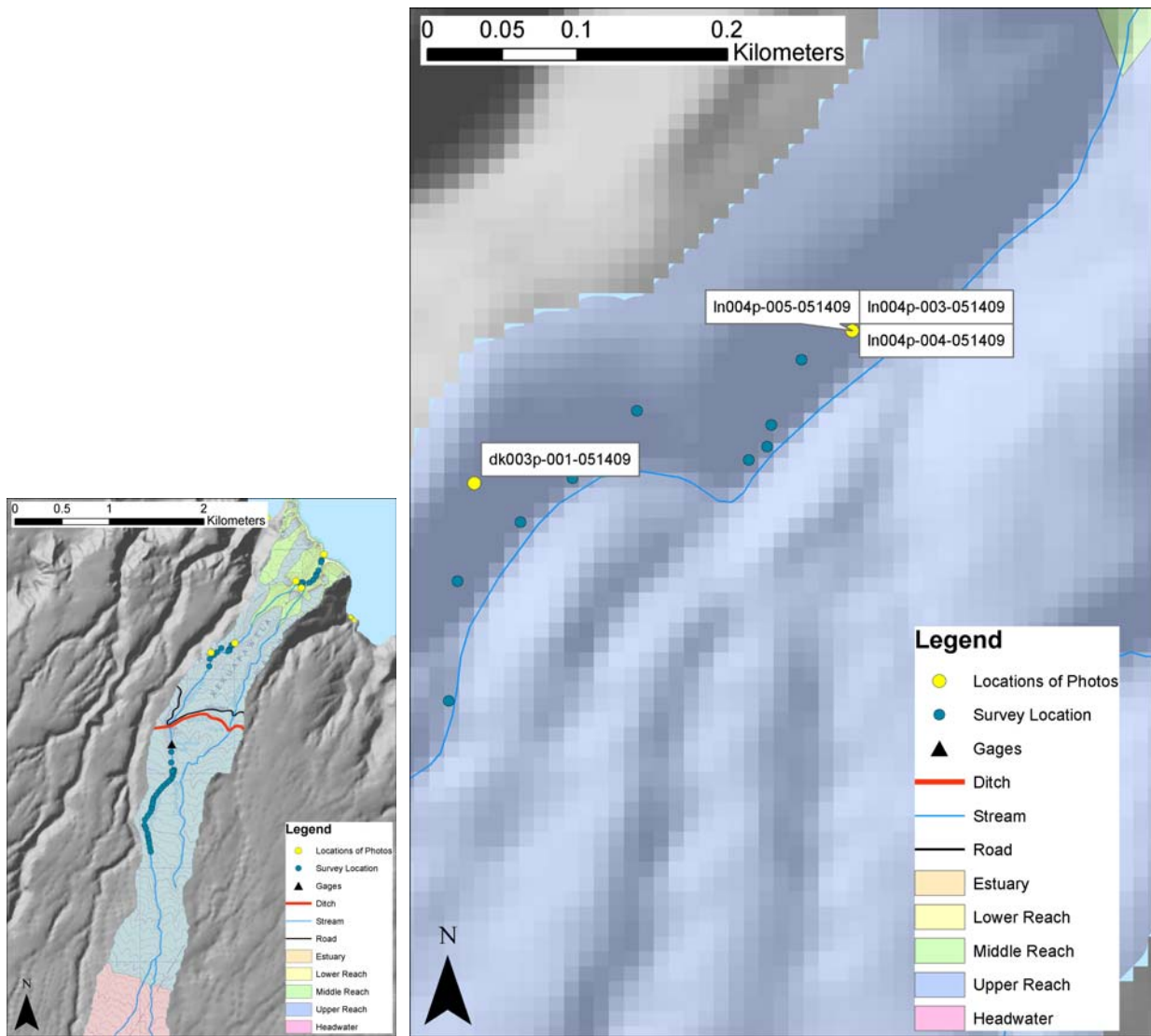


Figure 5-18. Photo locations in the upper reach of Kopili'ula Stream.



Figure 5-19. Aerial photo of the upper reach. Note the low flow and the lack of white water. (5/13/2009; Tributary name: Kopili'ula (64017003); PBN: sh64017003p-019-051309; Photo by: Hau, S.).



Figure 5-20. Photo shows the location of survey site 4 (red circle). (5/14/2009; Tributary name: Kopili'ula (64017003); PBN: In004p-004-051409; Surveyor: Nishiura, L.; Habitat type: Run; SBN: In004r-05140; Lat. (DD): 20.82446, Long. (DD): -156.12726).



Figure 5-21. Photo is taken from the survey site 4 and is oriented downstream. (5/14/2009; Tributary name: Kopili'ula (64017003); PBN: In004p-003-051409; Surveyor: Nishiura, L.; Habitat type: Run; SBN: In004r-051409; Lat. (DD): 20.82446, Long. (DD): -156.12726).



Figure 5-22. Irrigation line (black pipe) of unknown origins at survey site 4. (5/14/2009; Tributary name: Kopili'ula (64017003); PBN: In004p-005-051409; Surveyor: Nishiura, L.; Habitat type: Run; SBN: In004r-051409; Lat. (DD): 20.82446, Long. (DD): -156.12726).



Figure 5-23. Waterfall with low flow in upper reach of Kopili‘ula Stream. Survey site 3 at base of falls. (5/14/2009; Tributary name: Kopili‘ula (64017003); PBN: dk003p-001-051409; Surveyor: Kuamo‘o, D.; Habitat type: Pool; SBN: dk003r-051409; Lat. (DD): 20.82358, Long. (DD): -156.12970).



Figure 5-24. Aerial photo of Kopili‘ula Stream showing waterfalls below Hāna Highway during rainfall event. (4/8/2009; Tributary name: Kopili‘ula (64017003); Photo by: Hau, S.).



Figure 5-25. Aerial photo of upper reach of Kopili‘ula Stream below Hāna Highway. Notice the low flow and the lack of white water between pools (dry period). (5/13/2009; Tributary name: Kopili‘ula (64017003); PBN: sh64017003p-022-051309; Photo by: Hau, S.).



Figure 5-26. Aerial photo of upper reach of Kopili‘ula Stream above Hāna Highway. Notice change in stream flow and the presence of white water. (Survey sites 1-3). (5/13/2009; Tributary name: Kopili‘ula (64017003); PBN: sh64017003p-024-051309; Photo by: Hau, S.).

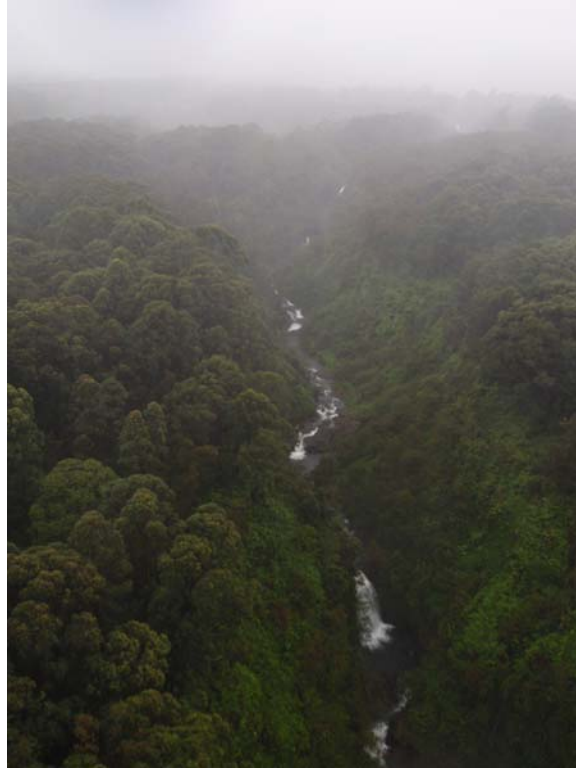


Figure 5-27. Aerial photo of Kopili‘ula Stream showing stair casing waterfalls above Hāna Highway. (4/8/2009; Tributary name: Kopili‘ula, Photo by: Hau, S.).

References

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

Tributary	Stream	Survey Book #	Site	Surveyor	Date	Latitude	Longitude
64017001	Kopili'ula	dk001x-051309		Kuamo'o, Darrell	5/13/2009	20.83227	-156.11827
64017001	Kopili'ula	dk007x-051309		Kuamo'o, Darrell	5/13/2009	20.83014	-156.11958
64017001	Kopili'ula	ln005x-051309		Nishiura, Lance	5/13/2009	20.83073	-156.11887
64017001	Kopili'ula	dk001r-051309	1	Kuamo'o, Darrell	5/13/2009	20.83227	-156.11827
64017001	Kopili'ula	ln002r-051309	2	Nishiura, Lance	5/13/2009	20.83206	-156.11835
64017001	Kopili'ula	ts003r-051309	3	Shimoda, Troy	5/13/2009	20.83129	-156.11861
64017001	Kopili'ula	dk004r-051309	4	Kuamo'o, Darrell	5/13/2009	20.83092	-156.11885
64017001	Kopili'ula	ln005r-051309	5	Nishiura, Lance	5/13/2009	20.83073	-156.11887
64017001	Kopili'ula	ts006r-051309	6	Shimoda, Troy	5/13/2009	20.83039	-156.11917
64017001	Kopili'ula	dk007r-051309	7	Kuamo'o, Darrell	5/13/2009	20.83014	-156.11958
64017002	Kopili'ula	dk011r-051309	11	Kuamo'o, Darrell	5/13/2009	20.83014	-156.12024
64017002	Kopili'ula	ln012r-051309	12	Nishiura, Lance	5/13/2009	20.82965	-156.12038
64017003	Kopili'ula	dk001r-012103	1	Kuamo'o, Darrell	1/21/2003	20.81240	-156.13366
64017003	Kopili'ula	sh002n-012103	2	Hau, Skippy	1/21/2003	20.81217	-156.13371
64017003	Kopili'ula	sh002r-012003	2	Hau, Skippy	1/21/2003	20.81217	-156.13371
64017003	Kopili'ula	gh003r-012103	3	Higashi, Glenn	1/21/2003	20.81188	-156.13382
64017003	Kopili'ula	gh004r-012103	4	Higashi, Glenn	1/21/2003	20.81159	-156.13397
64017003	Kopili'ula	sh005r-012103	5	Hau, Skippy	1/21/2003	20.81137	-156.13422
64017003	Kopili'ula	dk006r-012103	6	Kuamo'o, Darrell	1/21/2003	20.81115	-156.13449
64017003	Kopili'ula	dk007r-012103	7	Kuamo'o, Darrell	1/21/2003	20.81091	-156.13479
64017003	Kopili'ula	rn008r-012103	8	Nishimoto, Robert	1/21/2003	20.81066	-156.13502
64017003	Kopili'ula	sh009r-012103	9	Hau, Skippy	1/21/2003	20.81008	-156.13552
64017003	Kopili'ula	dk010r-012103	10	Kuamo'o, Darrell	1/21/2003	20.81039	-156.13526
64017003	Kopili'ula	gh011r-012103	11	Higashi, Glenn	1/21/2003	20.80980	-156.13576
64017003	Kopili'ula	rn012r-012103	12	Nishimoto, Robert	1/21/2003	20.80952	-156.13586

Appendix: Survey Sites Latitude and Longitude (continued)

Tributary	Stream	Survey Book #	Site	Surveyor	Date	Latitude	Longitude
64017003	Kopili'ula	sh013r-012103	13	Hau, Skippy	1/21/2003	20.80924	-156.13591
64017003	Kopili'ula	dk014r-012103	14	Kuamo'o, Darrell	1/21/2003	20.80894	-156.13598
64017003	Kopili'ula	gh015r-012103	15	Higashi, Glenn	1/21/2003	20.80873	-156.13602
64017003	Kopili'ula	rn016r-012103	16	Nishimoto, Robert	1/21/2003	20.80842	-156.13616
64017003	Kopili'ula	sh017r-012103	17	Hau, Skippy	1/21/2003	20.80808	-156.13643
64017003	Kopili'ula	dk018r-012103	18	Kuamo'o, Darrell	1/21/2003	20.80772	-156.13672
64017003	Kopili'ula	gh019r-012103	19	Higashi, Glenn	1/21/2003	20.80720	-156.13678
64017003	Kopili'ula	rn020r-012103	20	Nishimoto, Robert	1/21/2003	20.80686	-156.13663
64017003	Kopili'ula	sh021n-012103	21	Hau, Skippy	1/21/2003	20.80686	-156.13663
64017003	Kopili'ula	sh022n-012103	22	Hau, Skippy	1/21/2003	20.80641	-156.13647
64017003	Kopili'ula	gh023r-012103	23	Higashi, Glenn	1/21/2003	20.80609	-156.13642
64017003	Kopili'ula	rn024r-012103	24	Nishimoto, Robert	1/21/2003	20.80576	-156.13636
64017003	Kopili'ula	dk025r-012103	25	Kuamo'o, Darrell	1/21/2003	20.80576	-156.13636
64017003	Kopili'ula	sh026r-012103	26	Hau, Skippy	1/21/2003	20.80543	-156.13631
64017003	Kopili'ula	gh027n-012103	27	Higashi, Glenn	1/21/2003	20.80502	-156.13625
64017003	Kopili'ula	gh029r-012103	29	Higashi, Glenn	1/21/2003	20.80502	-156.13625
64017003	Kopili'ula	dk029r-012103	29	Kuamo'o, Darrell	1/21/2003	20.80464	-156.13618
64017003	Kopili'ula	sh030n-012103	30	Hau, Skippy	1/21/2003	20.80464	-156.13618
64017003	Kopili'ula	sh001r-051309	1	Hau, Skippy	5/13/2009	20.81413	-156.13391
64017003	Kopili'ula	tss002r-051309	2	Sakihara, Troy	5/13/2009	20.81312	-156.13393
64017003	Kopili'ula	tts003r-051309	3	Shindo, Tim	5/13/2009	20.81227	-156.13388
64017003	Kopili'ula	sh003n-051309	3	Hau, Skippy	5/13/2009	20.81230	-156.13374
64017003	Kopili'ula	ln007r-051309	7	Nishiura, Lance	5/13/2009	20.83018	-156.12029
64017003	Kopili'ula	ts009r-051309	9	Shimoda, Troy	5/13/2009	20.83005	-156.12045
64017003	Kopili'ula	dk010r-051309	10	Kuamo'o, Darrell	5/13/2009	20.83030	-156.12091
64017003	Kopili'ula	ts008x-051409		Shimoda, Troy	5/14/2009	20.82369	-156.12794

Appendix: Survey Sites Latitude and Longitude (continued)

Tributary	Stream	Survey Book #	Site	Surveyor	Date	Latitude	Longitude
64017003	Kopili'ula	dk009x-051409		Kuamo'o, Darrell	5/14/2009	20.82400	-156.12865
64017003	Kopili'ula	ln001x-051409		Nishiura, Lance	5/14/2009	20.82299	-156.12982
64017003	Kopili'ula	dk003x-051409		Kuamo'o, Darrell	5/14/2009	20.82358	-156.12970
64017003	Kopili'ula	ln001n-051409	1	Nishiura, Lance	5/14/2009	20.82299	-156.12982
64017003	Kopili'ula	ts002n-051409	2	Shimoda, Troy	5/14/2009	20.82227	-156.12989
64017003	Kopili'ula	dk003r-051409	3	Kuamo'o, Darrell	5/14/2009	20.82358	-156.12970
64017003	Kopili'ula	ln004r-051409	4	Nishiura, Lance	5/14/2009	20.82446	-156.12726
64017003	Kopili'ula	ts005r-051409	5	Shimoda, Troy	5/14/2009	20.82429	-156.12759
64017003	Kopili'ula	dk006r-051409	6	Kuamo'o, Darrell	5/14/2009	20.82390	-156.12779
64017003	Kopili'ula	ln007r-051409	7	Nishiura, Lance	5/14/2009	20.82377	-156.12782
64017003	Kopili'ula	ts008r-051409	8	Shimoda, Troy	5/14/2009	20.82369	-156.12794
64017003	Kopili'ula	dk009r-051409	9	Kuamo'o, Darrell	5/14/2009	20.82400	-156.12865
64017003	Kopili'ula	ln010r-051409	10	Nishiura, Lance	5/14/2009	20.82360	-156.12907
64017003	Kopili'ula	ts011r-051409	11	Shimoda, Troy	5/14/2009	20.82334	-156.12941

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