Report on Honopou Stream
Maui, Hawaii

June 2008

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

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

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

Authors:
Glenn Higashi[1], James Parham[2], Skippy Hau[1], Robert Nishimoto[1], Dan Polhemus[1], Eko Lapp[1], Lance Nishihara[1], Tim Shindo[1], and Troy Sakihara[1]

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Section 1: Overview

Introduction:

This report is an accounting of the aquatic resources that have been observed in Honopou Stream, Maui. The report was generated to provide some information to aid in the instream flow determination for the East Maui Streams at the request of the Commission on Water Resource Management (CWRM). The focus of this report is the animals that live in the stream and the data collected during surveys of the stream. The report covers six main sections, including:

- Overview
- Watershed Atlas Report
- DAR Point Quadrat Survey Report
- DAR Insect Survey Report
- An Analysis of Depth Use vs. Availability
- Photographs of stream taken during stream surveys

The overview provides the introduction 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of the watershed and its aquatic resources from Divisiion of Aquatic Resources (DAR) and other published and unpublished surveys as well as a rating of the condition of the stream compared to other streams on Maui as well as statewide.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 Insect Survey Report describes the distribution, habitats, and species of insects observed in the stream. The analysis of depth use vs. availability looks at habitat use by native species and the availability of suitable depths in the stream. 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 condition of Honopou Stream while also providing substantial evidence to support the conclusions presented.

Findings for Honopou Stream, Maui:

Honopou is a small (2.8 square miles), narrow watershed. Its zoning status is split between conservation (57%) and agricultural (47%) and the land cover is mostly evergreen forest (60%), scrub (19%), cultivated land (12%), and grassland (5%). Stream surveys were completed in Honopou Stream during 2007 and 2008. This watershed rates average in comparison to other watersheds in Maui and statewide. It has a total watershed rating of 5 out of 10, a total biological rating of 5 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, Lentipes concolor,* and *Sicyopterus stimpsoni.*

Crustaceans - *Atyoida bisulcata* and *Macrobrachium grandimanus*

Mollusks – No native mollusks were observed

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

Fish - *Poecilia reticulata, Poecilia sp.* and *Xiphophorus helleri*

Crustaceans - *Macrobrachium lar*

Mollusks – *Melanoides tuberculata*

Also observed in this watershed are the two native dragonflies, *Anax strenuus* and *Pantala flavescens* and the native damselfly, *Megalagrion pacificum*, which is currently a candidate for listings as an endangered species.

Most native animals were observed using sites with deeper water, although the low number of native species made depth suitability determination impossible. In general, Honopou stream is shallower then would be expected in a normal stream. This is likely restricting native adult animal habitat.

Photographs were taken of interesting features of stream habitat and diversions. Photographs show that dry sections exist downstream of diversions. The photographs document a problem with the use of water passing through PVC pipes that limit upstream migration.

Discussion for Honopou Stream, Maui:

Honopou is a moderately steep watershed that has good access and much of the stream can be hiked. There are several waterfalls on this stream and several deep pools are being used as swimming holes by local residents. This stream does not have a terminal waterfall and ends in a rocky beach. This stream is very dependent on rainfall for stream flow. Typical stream discharge in the lower end is not enough for downstream taro users that depend on an auwai intake from the stream. There are other agricultural uses next to the lower stream including organic farming and tropical flowers.

This watershed rates average for Maui and statewide. This average rating reflects the findings of native animals and introduced species as well as the fact that this watershed is not overly large or contains large amounts of diverse habitats. Although, the rating is about average, Honopou has the potential to sustain much larger populations of native species than are currently observed.

The presence of many of the native fishes in this stream is a positive sign that some habitat exists in this stream. The availability of suitable depths suggest that large sections of stream are currently not highly suitable for native animals and this supported by the

low numbers of native amphidromous animals observed. The amount and availability of suitable habitat for adult amphidromous animals may be enhanced by increased flows and increased stream connectivity.

Honopou Stream contains a highly degraded aquatic insect biota in its lower reaches that have been dewatered by ditch diversions, while by contrast supporting a robust, native-dominated aquatic insect assemblage in the upper reaches above the points of diversion. The latter assemblage also contains one species, the native damselfly *Megalagrion pacificum*, which is currently proposed for listing as Endangered under the federal Endangered Species Act. Restoration of flow to the dewatered sections of this catchment would in all likelihood result in a corresponding restoration of native aquatic insect diversity, but only if steps were taken to avoid utilizing ditch waters that are heavily colonized by invasive poeciliid fishes.

Post larval recruitment of native fish and macroinvertebrates was observed near the mouth of this stream. The diversions that fully dewater the stream under normal flows likely restrict larval upstream migration. The Haiku Ditch Diversion has three pipes that allow surface water to pass over the ditch. Unfortunately, the water falls from the pipes back into the streambed and will not allow upstream passage of native stream animals unless there are high flood flows. Additionally, this stream flows directly into the Lowrie irrigation ditch and likely entrains downstream drifting larvae.

Swordtails were in the upper reach and guppies were in the middle reach. These introduced species live in the deep pools created above the diversion structure and in the ditches. These poeciliid fishes have been known to carry and transmit parasites to native fishes. High flows alone are unlikely to remove all poeciliid fish populations as they can reestablish themselves from the ditch populations.

This stream is continuous through much of its length although there is a grating at the upper diversion at Wailoa ditch which diverts all of the water under most discharge conditions.

There are at least two different diversion sites on this stream. The main problem with the diversions in this stream is the blockage of upstream migration with the use of pipes (see photographs for more information). The diversions have significantly reduced baseflows in this stream which limits overall habitat for native species.

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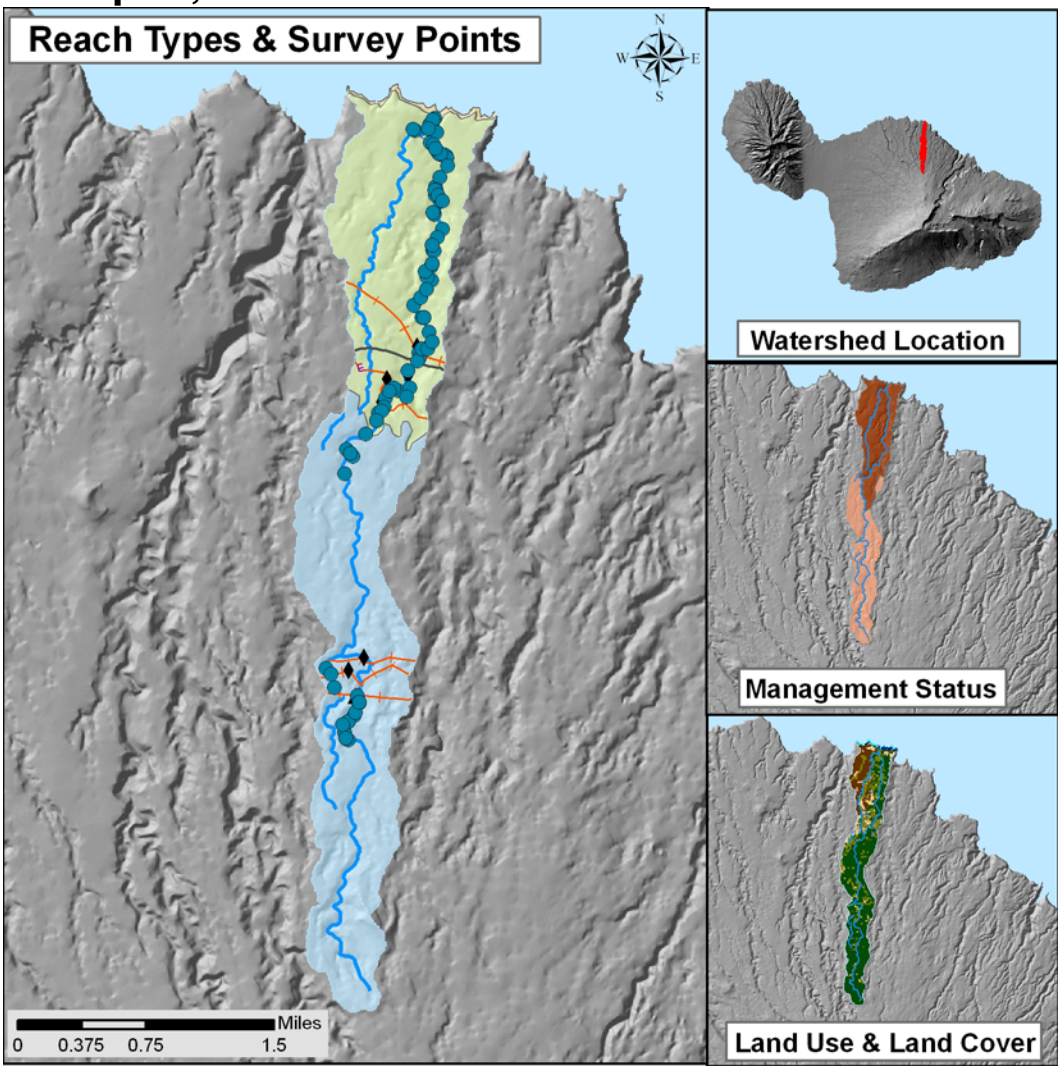
Section 2: Watershed Atlas Report

Section 2: Watershed Atlas Report

DAR Watershed Code: 63008

Honopou, Maui



WATERSHED FEATURES

Honopou watershed occurs on the island of Maui. The Hawaiian meaning of the name is “post Harbor”. The area of the watershed is 2.8 square mi (7.3 square km), with maximum elevation of 2287 ft (697 m). The watershed's DAR cluster code is 3, meaning that the watershed is medium small, steep in the upper watershed, and with some embayment. The percent of the watershed in the different land use districts is as follows: 42.9% agricultural, 57.1% conservation, 0% rural, and 0% urban.

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

Military	Federal	State	OHA	County	Nature Conservancy	Other Private
0.0	0.0	51.4	0.0	0.0	0.0	48.

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

Permanent Biodiversity Protection	Managed for Multiple Uses	Protected but Unmanaged	Unprotected
0.0	51.4	0.0	48.6

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	1.9	0.05	0.14
Cultivated	11.8	0.33	0.86
Grassland	5.2	0.15	0.38
Scrub/Shrub	18.7	0.53	1.36
Evergreen Forest	60.1	1.69	4.37
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	0.2	0.01	0.01
Unconsolidated Shoreline	1.2	0.03	0.08
Water	0.9	0.03	0.06
Unclassified	0.0	0.00	0.00

STREAM FEATURES

Honopou is a perennial stream. Total stream length is 10.2 mi (16.5 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.

Estuary	Lower	Middle	Upper	Headwaters
0.0	3.4	43.0	53.7	0.0

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

BIOTIC SAMPLING EFFORT

Biotic samples were gathered in the following year(s):
2007 2008

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

Survey type	Estuary	Lower	Middle	Upper	Headwaters
DAR Point Quadrat	0	12	60	24	0

BIOTA INFORMATION

Species List

Native Species

Crustaceans	*Atyoida bisulcata*
	Macrobrachium grandimanus
Fish	*Awaous guamensis*
	Eleotris sandwicensis
	Lentipes concolor
	Sicyopterus stimpsoni

Native Species

Insects	*Anax strenuus*
	Campsicnemus exiguus

Introduced Species

Amphibians	*Bufo marinus*
	Rana rugosa
	Ranidae sp.
Crustaceans	*Macrobrachium lar*
Fish	*Poecilia reticulata*
	Poeciliidae sp.
	Xiphophorus helleri
Snails	*Melanoides tuberculata*

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

Scientific Name	Status	Minimum Size	Maximum Size	Average Size
Bufo marinus	Introduced	0.25	2.5	0.5
Rana rugosa	Introduced	2	3.5	2.8
Ranidae sp.	Introduced	1	1	1.0
Atyoida bisulcata	Endemic	0.25	1.5	1.2
Macrobrachium grandimanus	Endemic	1.25	1.25	1.3
Macrobrachium lar	Introduced	0.5	6	2.8
Eleotris sandwicensis	Endemic	2	2	2.0
Lentipes concolor	Endemic	2.25	2.25	2.3
Sicyopterus stimpsoni	Endemic	2.25	4	3.1
Awaous guamensis	Indigenous	1.25	7	4.2
Poecilia reticulata	Introduced	0.5	1	0.7
Poeciliidae sp.	Introduced	0.25	0.25	0.3
Xiphophorus helleri	Introduced	0.75	2	1.2
Campsicnemus exiguus	Endemic	1.5	1.5	1.5
Melanoides tuberculata	Introduced	0.75	0.75	0.8

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	Low	Mid	Upper	Headwaters
Atyoida bisulcata	Endemic		0.43		0.69	
Campsicnemus exiguus	Endemic			0.06		
Lentipes concolor	Endemic				0.14	
Macrobrachium grandimanus	Endemic		0.43			

Sicyopterus stimpsoni	Endemic		0.06	
Awaous guamensis	Indigenous	0.86	0.38	
Bufo marinus	Introduced			1.24
Macrobrachium lar	Introduced	3	2.76	
Melanoides tuberculata	Introduced			0.14
Poecilia reticulata	Introduced		0.25	
Rana rugosa	Introduced			0.41
Xiphophorus helleri	Introduced			0.41

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

Scientific Name	Status	Estuary	Lower	Middle	Upper	Headwaters
Atyoida bisulcata	Endemic		P		P	
Macrobrachium grandimanus	Endemic		P			
Eleotris sandwicensis	Endemic		P			
Lentipes concolor	Endemic				P	
Sicyopterus stimpsoni	Endemic			P		
Anax strenuus	Endemic		P			
Campsicnemus exiguus	Endemic			P		
Awaous guamensis	Indigenous		P	P		
Bufo marinus	Introduced				P	
Rana rugosa	Introduced				P	
Ranidae sp.	Introduced				P	
Macrobrachium lar	Introduced		P	P	P	
Poecilia reticulata	Introduced			P		
Poeciliidae sp.	Introduced		P	P		
Xiphophorus helleri	Introduced			P	P	
Melanoides tuberculata	Introduced				P	

HISTORIC RANKINGS

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

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

Hawaii Stream Assessment Rank (1990): not ranked

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 > 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

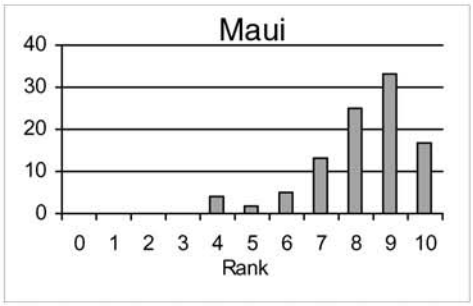
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding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

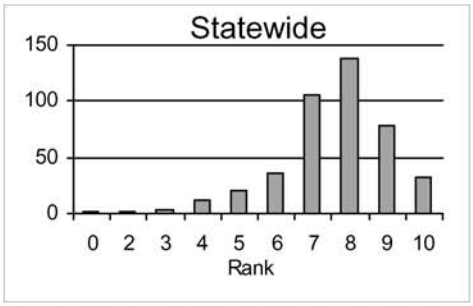
WATERSHED RATING: Honopou, Maui

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

Watershed Rating

8

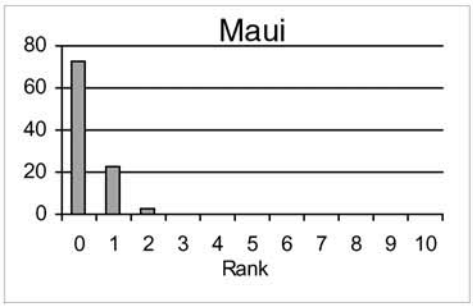


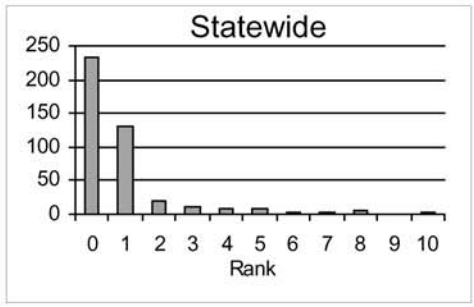


Shallow Waters Rating: Rating is based on a combination of the extent of estuarine and shallow marine areas associated with the watershed and stream.

Watershed Rating

1

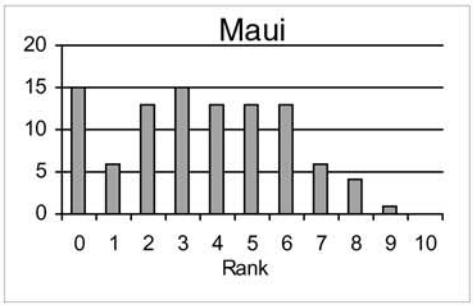


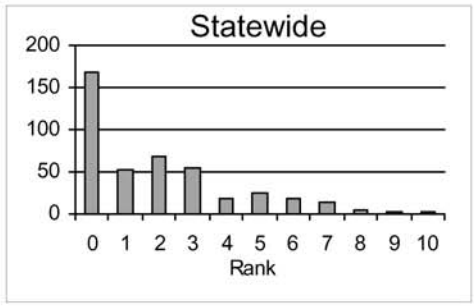


Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.

Watershed Rating

3

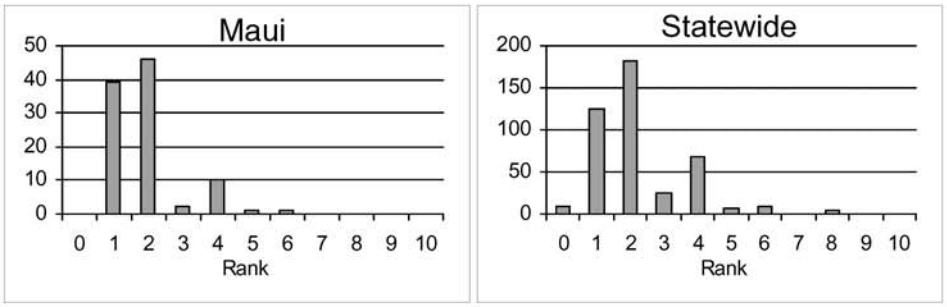




WATERSHED RATING (Cont): Honopou, Maui

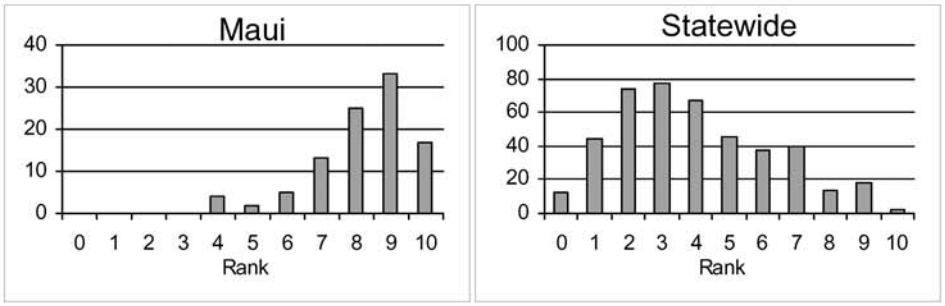
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.

Watershed Rating
2



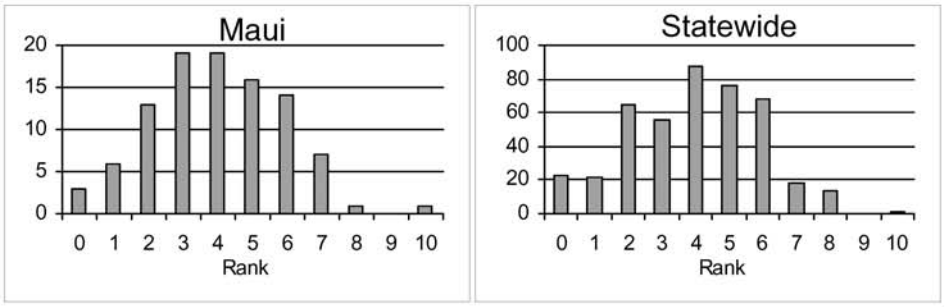
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.

Watershed Rating
5



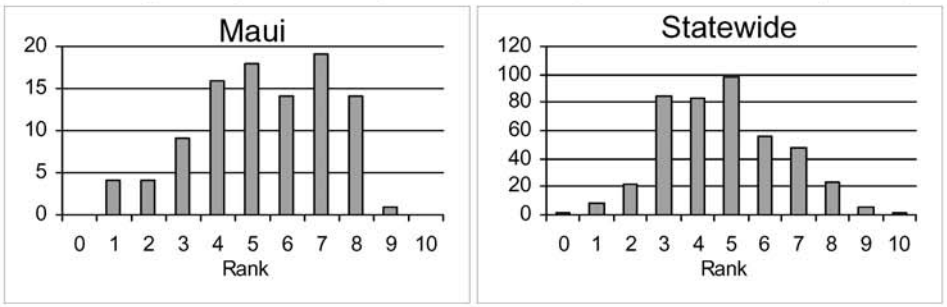
Reach Diversity Rating: Rating is based on the types and amounts of different stream reaches available in the watershed. More area in different reach types score more positively.

Watershed Rating
4



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
5

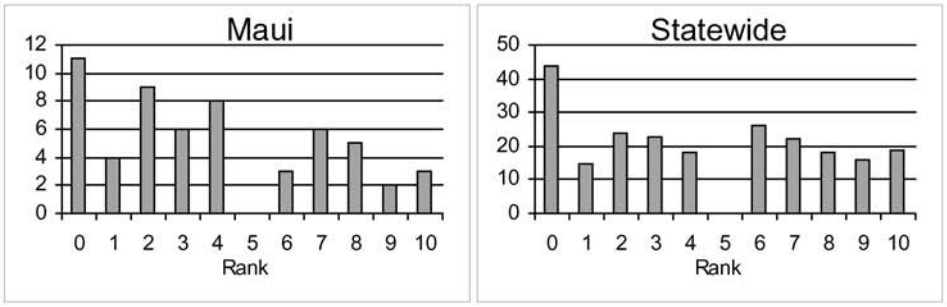


BIOLOGICAL RATING: Honopou, Maui

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

Stream Rating

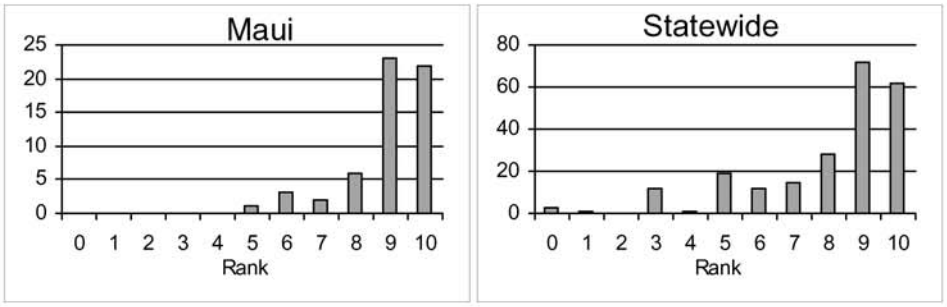
7



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

Stream Rating

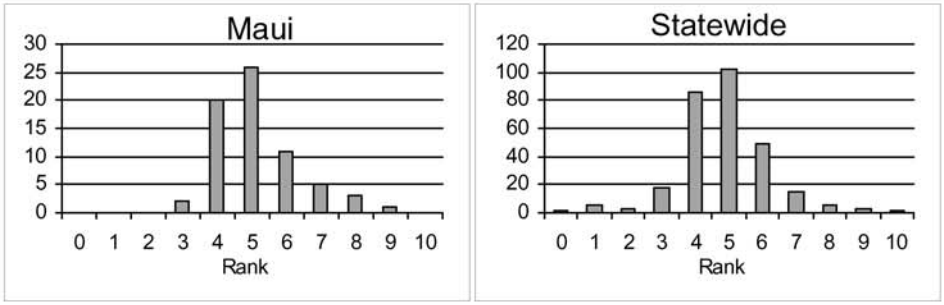
6



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

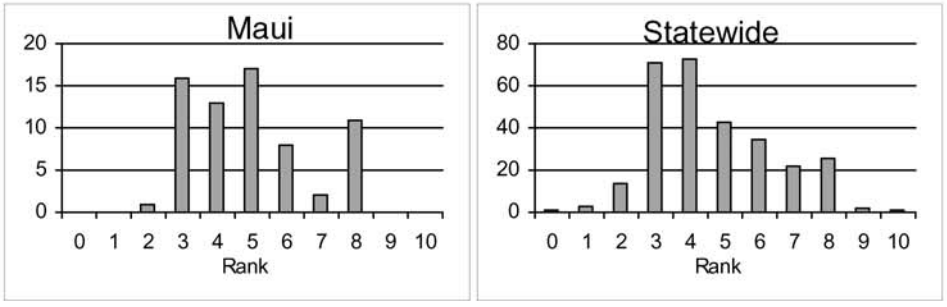
4



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

Stream Rating

5

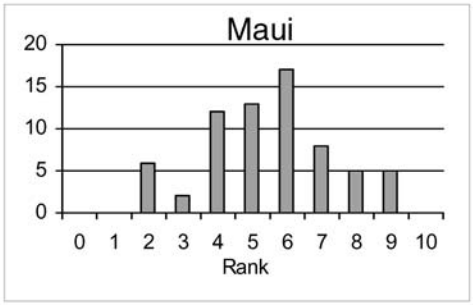


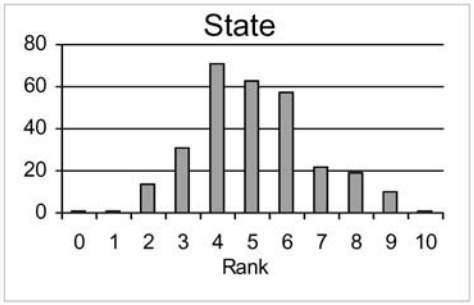
OVERALL RATING: Honopou, Maui

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

Watershed Rating

5



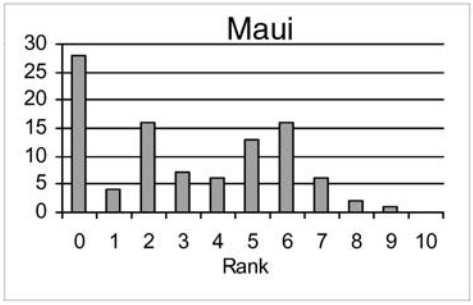


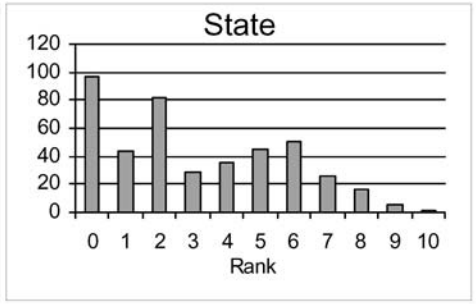
RATING STRENGTH: Honopou, Maui

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

6





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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. DAR Insect Survey Data from Dan Polhemus spreadsheets.

Appendix 1: Scientific and Common Names

Appendix 1: Scientific and Common Names

CN = Common Name and HN = Hawaiian Name

Amphibian

Introduced

Bufo marinus
CN: marine toad; HN: none.

Rana rugosa
CN: wrinkled frog; HN: none.

Ranidae sp.
CN: none; HN: none.

Ranidae sp.
CN: unidentified frog; HN: none.

Ranidae sp.
CN: unidentified frog tadpole; HN: none.

Crustacean

Endemic

Atyoida bisulcata
CN: Mountain opae; HN: `opae kala`ole.

Macrobrachium grandimanus
CN: Hawaiian prawn; HN: opae 'oeha'a.

Introduced

Macrobrachium lar
CN: none; HN: none.

Fish

Endemic

Eleotris sandwicensis
CN: Hawaiian sleeper; HN: `O`opu akupa.

Lentipes concolor
CN: `O`opu alamo`o; HN: `O`opu alamo`o.

Sicyopterus stimpsoni
CN: `O`opu nōpili; HN: `O`opu nopili.

Indigenous

Awaous guamensis
CN: none; HN: `O`opu nakea.

Introduced

Poecilia reticulata
CN: Guppy (AFS), Rainbow fish (Yamamoto & Tagawa, 2000), Millions fish (Yamamoto & Tagawa, 2000); HN: none.

Poeciliidae sp.
CN: unidentified livebearers; HN: none.

Xiphophorus helleri
CN: Green swordtail; HN: none.

Appendix 1: Scientific and Common Names (continued)

CN = Common Name and HN = Hawaiian Name

Insect

Endemic

Anax strenuus
CN: blue dragonfly; HN: Pinao.

Campsicnemus exiguus
CN: none; HN: none.

Snail

Introduced

Melanoides tuberculata
CN: none; HN: none.

Section 3: DAR Point Quadrat Survey Report

DAR Point Quadrat Survey Report for Honopou Stream, Maui for surveys from 11/27/2007 to 3/7/2008

This Division of Aquatic Resources (DAR) stream surveys report is produced using the Point Quadrat Methodology. Trained biologists and technicians survey a series of randomly located points in a stream to generate an assessment of composition of species and habitats in the stream. The Point Quadrat Methodology is only one of several different techniques that could be chosen for the surveys and is used to develop a statistically comparable stream survey. The following information represents an accounting of the observations that will be used in overall stream management efforts by DAR. All density measurements are in number of animals per square yard in the reach.

Table 1. The watersheds (and watershed ID), region, and island surveyed in this report are:

Honopou (ID: 63008), Makawao, Maui

Table 2. Survey Team Personnel:

Hau, Skippy
Higashi, Glenn
Kuamoo, Darrell
Nishimoto, Robert
Nishiura, Lance
Sakihara, Troy
Shimoda, Troy

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

Stream Name	Estuary	Lower	Middle	Upper	Headwater	**Total**
Honopou		9	52	15		**76**

Lower Reach of Honopou Stream, Maui.

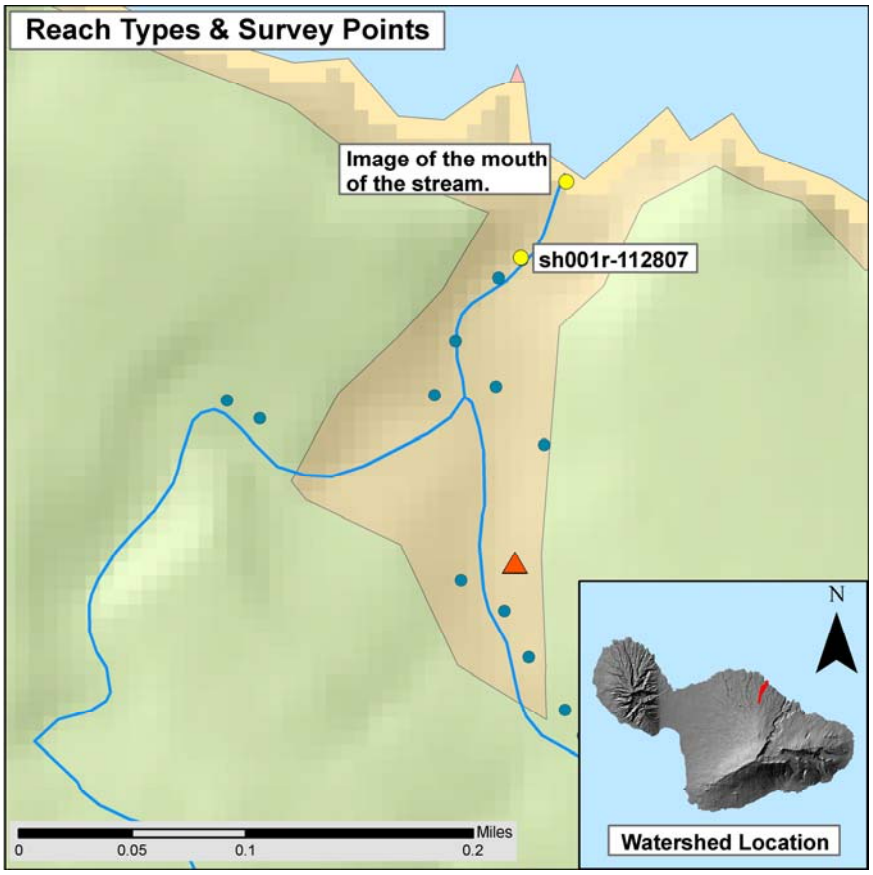

Figure 1. Represents the Point Quadrat Surveys done in the low reach of Honopou Stream. Blue Dots are the survey locations, the colors are the reach delineations, orange triangles are the diversions and yellow dots have pictures associated with them.

Lower Reach:

Habitat Types

Cascade	Riffle	Run	Pool	Plunge	Side pool	No water
	2	2	3			

Substrate Types in Surveys (%)

Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
3	3	0	4	21	33	34

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Crustaceans	Introduced	*Macrobrachium lar*	Lower	4.47	10
Crustaceans	Endemic	*Atyoida bisulcata*	Lower	0.45	1
Fish	Endemic	*Eleotris sandwicensis*	Lower	0.45	1
Fish	Indigenous	*Awaous guamensis*	Lower	0.45	1

Middle Reach of Honopou stream, Maui.

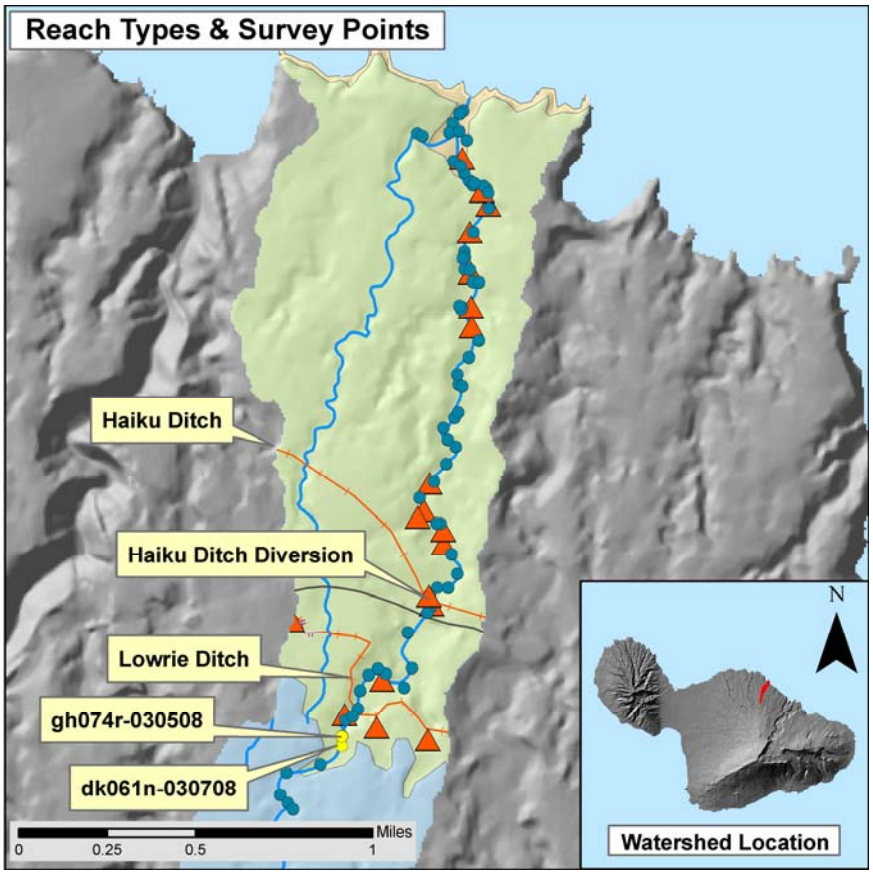

Figure 2. Locations of the Point Quadrat Surveys done in the middles reach of Honopou Stream. Blue dots are the survey locations, orange triangles are the diversions, orange hatched lines are the ditches, the colors are the reach delineations, and the dark gray line is a road. Yellow dots are site with associated photographs.

Middle Reach:

Habitat Types

Cascade	Riffle	Run	Pool	Plunge	Side pool	No Water
2	6	13	23	1	4	

Substrate Types in Surveys (%)

Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
7	5	2	11	16	30	30

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Crustaceans	Introduced	*Macrobrachium lar*	Middle	2.4	36
Fish	Introduced	*Poecilia reticulata*	Middle	0.27	4
Fish	Indigenous	*Awaous guamensis*	Middle	0.27	4

Fish	Endemic	*Sicyopterus stimpsoni*	Middle	0.07	1
Insects	Endemic	*Campsicnemus exiguus*	Middle	0.07	1

Upper Reach of Honopou Stream, Maui.

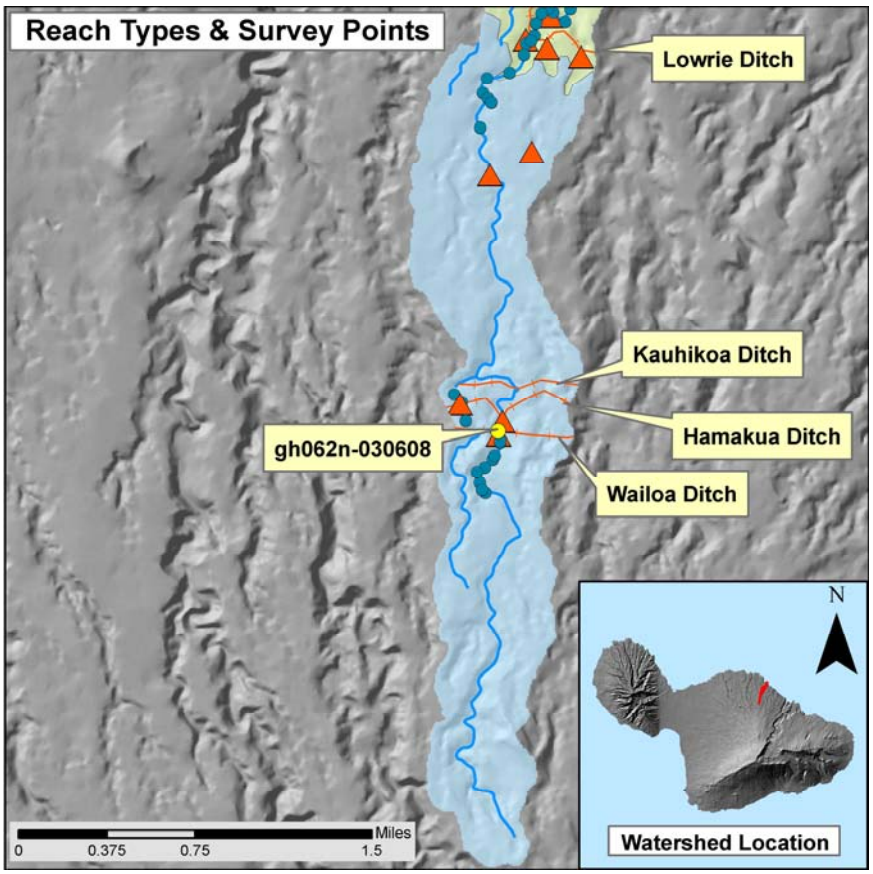

Figure 3. Locations of the Point Quadrat Surveys done in the upper reach of Honopou Stream. Blue Dots are the survey locations, the colors are the reach delineations, and the green labeled dots are site with associated photographs. The orange hatched lines are the location of irrigation ditches.

Upper Reach:

Habitat Types

Cascade	Riffle	Run	Pool	Plunge	Side pool	No Water
		8	3	2		1

Substrate Types in Surveys (%)

Detritus	Sediment	Sand	Gravel	Cobble	Boulder	Bedrock
3	2	0	10	16	24	45

Category	Status	*Scientific Name*	Reach	Avg. Density	Total # observed
Amphibians	Introduced	*Bufo marinus*	Upper	0.83	4
Crustaceans	Endemic	*Atyoida bisulcata*	Upper	0.42	2
Fish	Introduced	*Xiphophorus helleri*	Upper	0.62	3
Fish	Endemic	*Lentipes concolor*	Upper	0.21	1
Snails	Introduced	*Melanoides tuberculata*	Upper	0.21	1

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Section 4: DAR Aquatic Insect Report

AN ASSESSMENT OF AQUATIC INSECT DIVERSITY IN HONOPOU STREAM, EAST MAUI WATERSHED

Introduction

From 26 November 2007 to 16 May 2008**,** collections of aquatic insects were made from the Hanopou Stream catchment of eastern Maui, at elevations ranging from 90 to 1320 feet. This work, conducted in conjunction with more comprehensive biological surveys conducted by the State of Hawaii's Division of Aquatic Resources, and hydrological surveys conducted by the State's Commission on Water Resource Management, was intended to provide a preliminary estimate of aquatic insect species diversity in this stream system.

Aquatic insects are defined herein as those species spending some significant portion of their life cycle within the stream itself or in the immediately adjacent wet riparian zone. Ecological terms follow those defined in Polhemus et al. (1992).

Description of study site

The Honopou catchment lies on the northern slope of Haleakala volcano in eastern Maui. Honopou Stream is approximately 5 miles in length, heading at an elevation near 2200 feet on the flanks of a small secondary cone called Ulalena, and entering the sea between Puniawa Point and Honopou Point. The catchment occupies part of a broad planeze bounded on the west by the deep valley of Opana Stream, and on the east by the similarly deep valley of Kailua Stream, both of which head at elevations above 4000 feet. All of the other drainages lying within the roughly trapezoidal sector bounded by these two large gulches, including Honopou Stream, occupy less deeply incised valleys and have headwaters at or below 2500 feet elevation. The general surface geology of this portion of Haleakala consists of flows from the Kula lava series, over which the streams cascade in a stair step profile of alternating vertical falls and lower gradient reaches. Along the lower sections of these streams, within a mile of the sea, the older, underlying Honomanu series lavas have also been exposed, generally forming large waterfalls that create significant interruptions in the bed profiles, often marking the transition from the terminal reach to the midreach as one progresses upstream.

The general hydrology and physical characteristics of the Honopou catchment has been studied in detail by the State of Hawaii's Commission on Water Resource Management, and is not considered in further detail here.

Four stations were sampled along Honopou Stream between 90 and 1320 feet elevation. Details on the locations of these 4 sampling stations may be found in Tables 1–4. These stations were a subset of those used by other DAR biologists making point quadrat censuses of native fish populations along this same stream.

Methods

A total of 3 days of sampling time were spent making collections along Hanehoi Stream, using hand netting and localized pyrethrin fogging of hygropetric habitats. Insects were taken both within and beside the stream, and from the air above. The specimens collected were stored in 75 percent ethanol in the field, and subsequently transported to the Bishop Museum in Honolulu for curation and identification. For Odonata, some specimens were dry vouchered in glassine envelopes, and for large, easily recognized species of Anisoptera (dragonflies) sight records were taken in lieu of field captures.

Water temperatures were measured at all sampling stations, and varied from 18° to 23.5° C. The water temperatures and elevations at individual stations may be found in Tables 1-4.

Results

A total of 23 species of aquatic insects were collected during 2 days of sampling along Honopou Stream. These taxa are detailed in Tables 1–5 below. Of the taxa collected across all stations, 11 species, or 48 percent of the total, were taxa considered native to the Hawaiian Islands.

In the subsequent tables, the following taxon codes are used: N = native species, I = introduced species.

Table 1: Aquatic insect taxa sampled from Honopou Stream, Station 1, terminal reach, 3.5 mi. N. of Hana Hwy., 90 ft., water temp. 22 °C., 16 May 2008, 09:30–10:00 hrs. 20°55'54.4"N, 156°14'39.6"W

Insect Taxon	Taxon Type
DIPTERA	
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
HETEROPTERA	
Veliidae	
Microvelia vagans White	N
Number of taxa present	
Native	1
Introduced	3
Total	4
Percentage of native species richness	25 %

Table 2: Aquatic insect taxa sampled from Honopou Stream, Station 2, terminal reach, 3.3 mi. N. of Hana Hwy., 150 ft., water temp. 22 °C., 16 May 2008, 08:30–09:30 hrs. 20°55'42.3"N, 156°14'29.0"W

Insect Taxon	Taxon Type
DIPTERA	
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
Tipulidae	
Limonia jacoba (Alexander)	N
HETEROPTERA	
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Saldula exulans (White)	N
Veliidae	
Microvelia vagans White	N
ODONATA	
Aeschnidae	
Anax junius	I
Libellulidae	
Orthemis ferruginea (Fabricius)	I
Pantala flavescens (Fabricius)	N
Coenagrionidae	
Ischnura posita (Hagen)	I
Number of taxa present	
Native	4
Introduced	7
Total	11
Percentage of native species richness	36 %

Table 3: Aquatic insect taxa sampled from Honopou Stream, Station 3, at Haiku Ditch diversion point, below Hana Road, 430 ft., water temp. 23.5 °C., 27 November 2007, 15:00–15:45hrs.; 16 May 2008, 10:30-11:30 hrs. 20°54'53.1"N, 156°14'47.1"W

Insect Taxon	Taxon Type
COLEOPTERA	
Carabidae	
Bembidion sp. undet.	N
DIPTERA	
Chironomidae	
Chironomus esakii Tokunaga	I
Cricotopus bicinctus (Meigen)	I
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
Ephydridae	
Scatella amnica (Tenorio)	N
Scatella cilipes (Tenorio)	N
HETEROPTERA	
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Micracanthia humilis (Say)	I
Saldula exulans (White)	N
Veliidae	
Microvelia vagans White	N
ODONATA	
Libellulidae	
Pantala flavescens (Fabricius)	N
Coenagrionidae	
Ischnura posita (Hagen)	I
TRICHOPTERA	
Hydropsychidae	
Cheumatopsyche pettiti (Banks)	I
Number of taxa present	
Native	6
Introduced	9
Total	15
Percentage of native species richness	40 %

Table 4: Aquatic insect taxa sampled from Honopou Stream, Station 4, from Wailoa Ditch diversion point upstream to second fall, 1200–1320 ft., water temp was 19 °C., 27 November, 2007, 09:45–13:30 hrs.
20°53'14.2"N, 156°15'08.8"W

Insect Taxon	Taxon Type
DIPTERA	
Chironomidae	
Cricotopus bicinctus (Meigen)	I
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Dolichopus exsul Aldrich	I
Ephydridae	
Scatella cilipes (Tenorio)	N
Scatella clavipes (Tenorio)	N
Tipulidae	
Limonia advena (Alexander)	I
Limonia jacoba (Alexander)	N
HETEROPTERA	
Veliidae	
Microvelia vagans White	N
ODONATA	
Aeschnidae	
Anax strenuous Hagen	N
Coenagrionidae	
Ischnura posita (Hagen)	I
Ischnura ramburii (Selys-Longchamps)	I
Megalagrion pacificum (McLachlan)	N
Libellulidae	
Pantala flavescens (Fabricius)	N
Number of taxa present	
Native	7
Introduced	6
Total	13
Percentage of native species richness	54 %

Table 5: Summary of aquatic insect species taken across all combined sampling stations on Honopou Stream, from 90–1320 ft. elevation

Insect Taxon	Taxon Type
COLEOPTERA	
Carabidae	
Bembidion sp. undet.	N
DIPTERA	
Chironomidae	
Chironomus esakii Tokunaga	I
Cricotopus bicinctus (Meigen)	I
Culicidae	
Aedes albopictus (Skuse)	I
Dolichopodidae	
Chrysotus longipalpus Aldrich	I
Dolichopus exsul Aldrich	I
Ephydridae	
Scatella amnica (Tenorio)	N
Scatella cilipes (Tenorio)	N
Scatella clavipes (Tenorio)	N
Tipulidae	
Limonia advena (Alexander)	I
Limonia jacoba (Alexander)	N
HETEROPTERA	
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Micracanthia humilis (Say)	I
Saldula exulans (White)	N
Veliidae	
Microvelia vagans White	N
ODONATA	
Aeschnidae	
Anax junius	I
Anax strenuous Hagen	N
Coenagrionidae	
Ischnura posita (Hagen)	I
Ischnura ramburii (Selys-Longchamps)	I
Megalagrion pacificum (McLachlan)	N
Libellulidae	
Orthemis ferruginea (Fabricius)	I
Pantala flavescens (Fabricius)	N
TRICHOPTERA	
Hydropsychidae	
Cheumatopsyche pettiti (Banks)	I

Insect Taxon	Taxon Type
Number of taxa present	
Native	11
Introduced	12
Total	23
Percentage of native species richness	48 %

Table 6: Species richness versus elevations of sampling stations on Honopou Stream

Stream and Sampling Station	Elevation	% Native Species Richness
Station 1	90	25
Station 2	150	36
Station 3	430	40
Station 4	1200*	54

* = above point of uppermost diversion on system

Discussion

The present surveys clearly demonstrate that for aquatic insects, both the species richness and the percentage of native species representation decrease steadily as one moves downward in elevation through both the Honopou catchment (see Tables 1–6). In particular the aquatic insect biota of the dewatered mid- and terminal reaches is a highly reduced subset of that which would otherwise prevail. In the dewatered reaches of Hanehoi stream, the aquatic insect community of the remnant pools is reduced to a two species community consisting of the introduced mosquito *Aedes albopictus*, and the small native water bug *Microvelia vagans*. The latter is an adaptable generalist that feeds on fallen insects that become trapped in the surface film, and as such can also colonize temporary pools in roads and trails. In areas where some degree of flow is present, this basic community of "mozzies and micros" may be further augmented by two species of introduced dolichopodid flies, *Chrysotus longipalpus* and *Dolichopus exsul* which are ubiquitous components of disturbed aquatic ecosystems in lowland Hawaii. Native species that formerly occupied such stream reaches, such as the native damselfly *Megalagrion pacificum*, were notably absent from such dewatered reaches.

By contrast, the uppermost station sampled during this survey, lying along stream reach above the highest point of diversion in the system, supported a rich aquatic insect assemblage with 14 species present, with 70 percent of these being native species. These assemblages also included native damselflies in the genus *Megalagrion*, including *M. pacificum*, which is currently a candidate for listing as Endangered under the federal

Endangered Species Act. *Megalagrion pacificum* was found above the ditch diversions, but was not found at any sampling station below the diversions. This strongly implies that the diversions are to some extent limiting the range of this federal listing candidate in this catchment.

This can be illustrated by comparing the terminal reach stations along both streams to the lower reach of Hanawi Stream further to the east on the Hana Coast (Englund and Polhemus, 1993), which is fed by resurgent groundwater from Big Spring and thus retains a flow regime representative of undiverted East Maui streams. This comparative data is provided in Tables 9 and 10.

Table 7: Aquatic insect taxa sampled from Hanawi Stream, Station 1, nr. Nahiku, 0-100 ft.,water temp. 19.5° C., 8 October 1992. 20°49'40"N, 156°05'55"W

Insect Taxon	Taxon Type
DIPTERA	
Canaceidae	
Procanace acuminata Hardy & Delfinado	N
Procanace constricta Hardy & Delfinado	N
Ceratopogonidae	
Forcipomyia sp. undet.	N
Chironomidae	
Telmatogeton torrenticola (Terry)	N
Calopsectra hawaiiensis Hardy	N
Culicidae	
Aedes albopictus (Skuse)	I
Ephydridae	
Neoscatella amnica Tenorio	N
Neoscatella clavipes Wirth	N
Neoscatella warreni (Cresson)	N
Dolichopodidae	
Chrysosoma fraternum Van Duzee	N
Chrysotus pallidipalpus Van Duzee	N
Tipulidae	
Limonia advena (Alexander)	I
Limonia jacobus (Alexander)	N
HETEROPTERA	
Veliidae	
Microvelia vagans White	N
Mesoveliidae	
Mesovelia amoena Uhler	I
Saldidae	
Saldula exulans (White)	N

LEPIDOPTERA	
Cosmopterigidae	
Hyposmocoma sp. undet. 1	N
Hyposmocoma sp. undet. 2	N
ODONATA	
Aeschnidae	
Anax strenuus Hagen	N
Libellulidae	
Pantala flavescens (Fabricius)	N
Coenagrionidae	
Megalagrion blackburni McLachlan	N
Megalagrion pacificum (McLachlan)	N
Megalagrion calliphya (McLachlan)	N
TRICHOPTERA	
Hydropsychidae	
Cheumatopsyche pettiti (Banks)	I
Number of taxa present	
Native	20
Introduced	4
Total	24
Percentage of native species richness	83 %

Table 8: Species richness at lower elevation sampling stations on Hanehoi Stream, and comparison to lower Hanawi Stream

Stream and Sampling Station	Elevation	Total Species	% Native Species Richness
Honopou Stream			
Station 1	90	4	25
Station 2	150	11	36
Hanawi Stream			
Station 1	100	24	83

By contrast, the uppermost stations sampled during this survey, lying along stream reaches above the highest point of diversion in each system, supported rich aquatic insect assemblages with 13 species present, with 54 percent of these being native species. These assemblages consistently included native damselflies in the genus *Megalagrion*, including *M. pacificum*, which is currently a candidate for listing as Endangered under the federal Endangered Species Act. *Megalagrion pacificum* was found in the both the Honopou and Hanehoi stream catchments above the ditch diversions, but was not found

at any sampling station below the diversions. This strongly implies that the diversions are to some extent limiting the range of this federal listing candidate in these catchments.

Restoration of stream flows could potentially lead to the gradual development of a richer and more native aquatic insect community in the dewatered sections of these stream catchments. However, such flow restoration would need to be conducted with great care to ensure that the restored waters were derived from the streams themselves, and not commingled with ditch flows. Utilizing ditch flows would result in the introduction of invasive species which would effectively preclude the establishment of native species even if more water were provided. Therefore, stream waters and ditch waters should be segregated as strictly as possible to avoid biological contamination of target catchments by restoration flows.

For example, surveys along the New Hamakua Ditch found it to be swarming with alien poeciliid fishes, which were concentrated due to the low flow conditions. As a result, no native aquatic insects were present in or along the ditch, even though its clear waters provided potentially suitable habitat. The presence of Poeciliidae illustrates how the ditches provide lateral conduits for invasive species, and why simple flow restoration based on ditch water will not necessarily result in restoration of native biota. Because of the design of the intakes, particularly those on the Wailoa Ditch which have sharp, steep internal drops, the poeciliids due not bleed upstream past the diversion points. On gaining systems such as the Hoolawanui and the Nailiilihaele, where the ditch waters do not intermingle with those of the seepage fed pools that form downstream of the diversions in the otherwise dry bed due to hyporheic resurgence, species such as *Megalagrion pacificum* can successfully colonize the habitats thus formed. In such cases, restoration of flow from a direct ditch release would in fact probably be deleterious. A preferable solution for obtaining restoration flows would be ditch bypasses, via which water from upstream of the ditch intake could be shunted around the intake to a point downstream, thus bypassing the biologically contaminated ditch.

An alternate problem that was discussed in the context of the Waiahole Stream restoration case on Oahu was the possibility that restoration flows could re-establish connectivity between invasive-dominated terminal reaches and native-dominated mid- and headwater reaches. This does not seem to be a major problem in the case of the East Maui Watershed due to the presence of numerous large waterfalls that have formed along these stream courses as they cut into the Honomanu and Kula series lavas. Such natural breaks in the stream profile, which are effective filters to the upstream migration of invasive fishes, were not present in the Waiahole system, but are by contrast commonplace on Oahu.

Summary

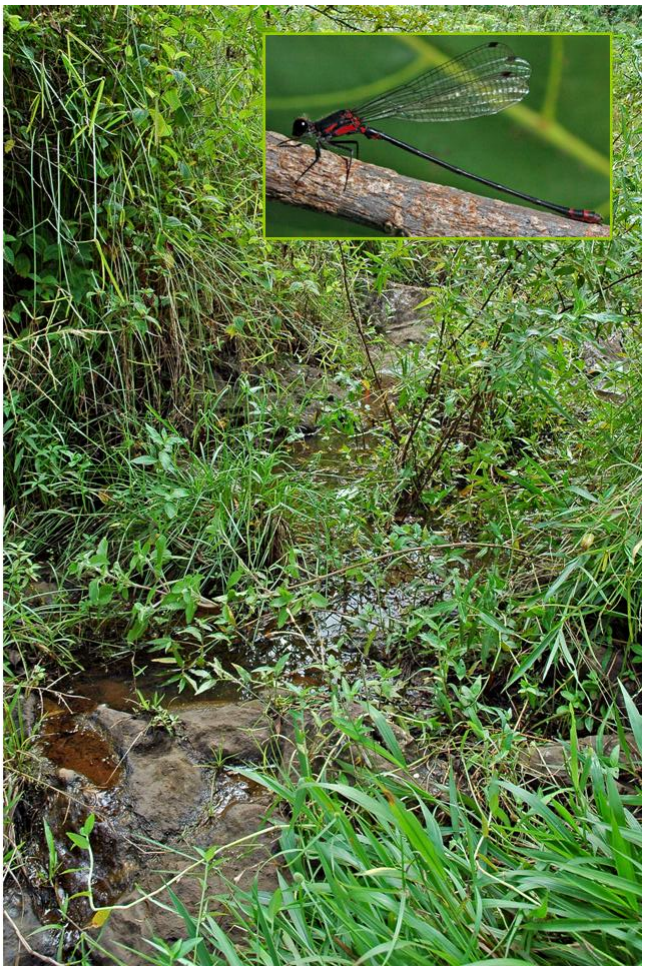
In summary, the Honopou catchment contains a highly degraded aquatic insect biota in its lower reaches that have been dewatered by ditch diversions, while by contrast supporting a robust, native-dominated aquatic insect assemblage in the upper reaches above the points of diversion. The latter assemblage also contains one species, the native damselfly *Megalagrion pacificum*, that is currently proposed for listing as Endangered

under the federal Endangered Species Act. Restoration of flow to the dewatered sections of this catchment would in all likelihood result in a corresponding restoration of native aquatic insect diversity, but only if steps were taken to avoid utilizing ditch waters that are heavily colonized by invasive poeciliid fishes.

Literature Cited

Englund, R. and D. A. Polhemus. 1993. A survey of the fish and aquatic insect fauna of the Hanawi and Makamakaole Streams, Maui, Hawaii. Unpublished consultant's report prepared for Natural Area Reserves System, Hawaii State Dept. of Land and Natural Resources. 64 pp.

Polhemus, D. A., J. Maciolek and J. Ford. 1992. An ecosystem classification of inland waters for the tropical Pacific islands. Micronesica, 25 (2): 155–173.



Habitat where the native damselfly, *M. pacificum* (inset) were observed. Taken by Dan Polhemus.

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Section 5: An Analysis of Depth Use vs. Availability

Introduction:

As part of an ongoing collaboration between the Division of Aquatic Resources and Bishop Museum, we have been analyzing the relationship between instream measures of habitat and the occurrence of native animals. The intention of this research is to better understand the habitat requirements of these animals to improve management of the stream environment. While this research effort is not complete, we have tried to provide some information to aid in the instream flow determination for the East Maui Streams given the deadlines for comment set by the Commission on Water Resource Management on these streams.

The amount of water in a stream is important to the fishes and macroinvertebrates that inhabit the stream. One measure of the amount of water needed in the stream to create suitable habitat is the depth of the water in a survey site. The deeper areas of a stream may be important to the animals to provide safety from predatory birds, a refuge from fluctuations in discharge, or as a buffer to changes in temperature as larger volumes of water heat or cool more slowly than smaller water volumes. Depth is also closely related to stream discharge. Given a specific stream bed form, increased discharge results in increases in depth and velocity. Conversely, if water is diverted from a stream, the decrease in downstream discharge results in slower, shallower water. Surveyors record the quadrat depth when using the DAR Point Quadrat technique, but do not measure velocity; therefore we used the depth in this analysis.

In this report, we compare the depth measured for each site during the DAR Point Quadrat Surveys of Honopou Stream, Maui to the depths where animals were observed. Additionally, we also compared the observations for Honopou Stream to depth observations for all streams statewide surveyed using Point Quadrat Surveys to see if the pattern for Honopou Stream is consistent with other Hawaiian streams. Finally, the distribution of average site depth by elevation groups is provided.

Methods:

All data reflected in this report came from the DAR Aquatics Surveys Database. For each random survey site in Honopou Stream, Maui (Watershed code = 63008) the depth and animals observed were queried from the database. Additionally, the same information was collected for all survey sites statewide.

To compare the depth suitability for the stream animals, availability, utilization, and suitability criteria were developed following standardized procedures (Bovee 1982). In general, this method based habitat utilization on the presence/absence data, and does not take into account site density. Depth availability is the frequency of each depth category based on the distribution of depths observed in the field survey. Percent availability is calculated by dividing the number of observations for a depth category by the total number of observations and multiplying by 100. Utilization is the frequency of occurrence for an individual species in each depth category. Percent utilization is calculated by dividing the number of sites with a species observed for a depth category

by the total number of sites with a species observed and multiplying by 100. Suitability is developed by dividing the percent utilization for each depth category with the percent availability for each depth category. The standardized suitability has the range adjusted so that the largest value for each species equals 1 (suitable) and the lowest value equals 0 (unsuitable).

To compare the site depths observed in the stream to the average site depths statewide, the percent frequency of occurrence for each depth bin was calculated from the data for Honopou Stream and for all sites statewide in the DAR Point Quadrat Surveys. Additionally, the difference between the percent frequencies for each depth bin wash plotted in a histogram to clearly show where the differences occurred.

To examine where in the stream changes in available depths occurred, the average depth was determined for a number of elevation bins. The determination of the distribution of the elevation bins was influenced by the number of samples in a depth bin. Where possible at least 5 samples were needed to create a depth bin.

Results:

There were insufficient observations of any native amphidromous animals to develop depth suitability criteria. In the random point quadrats, only three sites with *Atyoida bisulcata* were observed with an average depth of 12.7 inches, five sites with *Awaous guamensis* were observed with an average depth of 17.6 inches, and one site each for *Eleotris sandwicensis* (15 inches depth), *Lentipes concolor* (15 inches depth), and *Sicyopterus stimpsoni* (7 inches depth). In contrast to sites with native species, 34 sites with no animals of any type were observed and averaged 8.2 inches depth.

The pattern of the distribution of observed depths in Honopou Stream in comparison to the statewide average depths reveals that shallow sites are much more common in Honopou than in most Hawaiian Streams (Figure 1). The sample size was 72 sites for Honopou Stream in comparison to 6084 sites statewide. There were approximately 23% more shallow sites (10 inches or less) than observed in the statewide data set (Figure 2). In contrast to the increase in dry sites, there was a decrease in all depth bins 14 inches depth or deeper.

When observing the distribution of average depth as a function of elevation, the depths were generally stable or decreased slightly in a downstream direction (Figure 3). Most of the elevations bins had an average site depth between 10 and 13 inches.

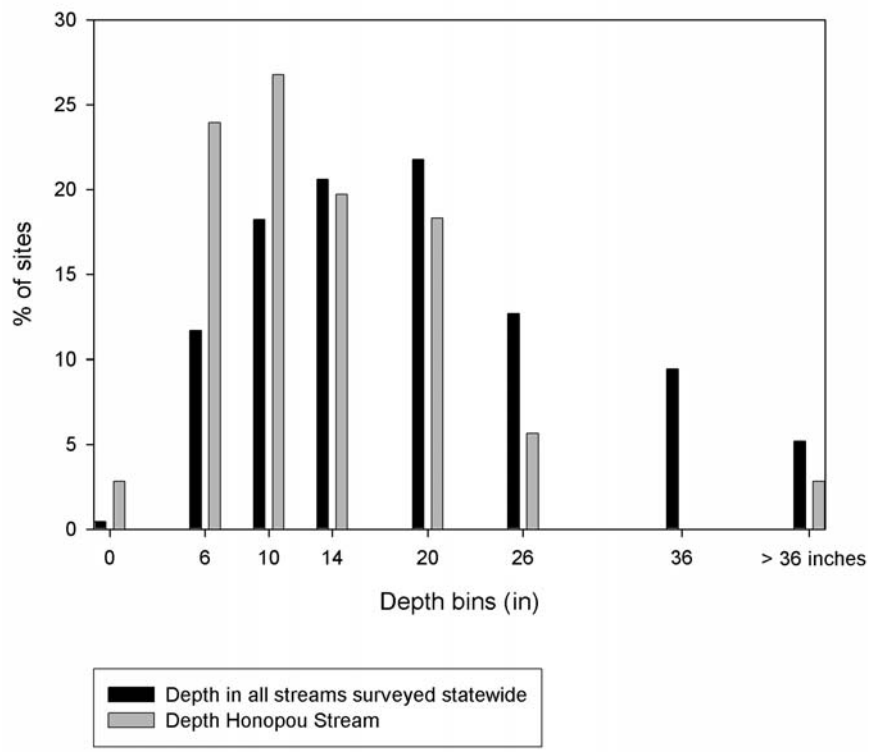

Figure 1. Comparison of percent availability for depth categories between Honopou Stream, Maui and all streams statewide in the DAR Aquatics Surveys Database.

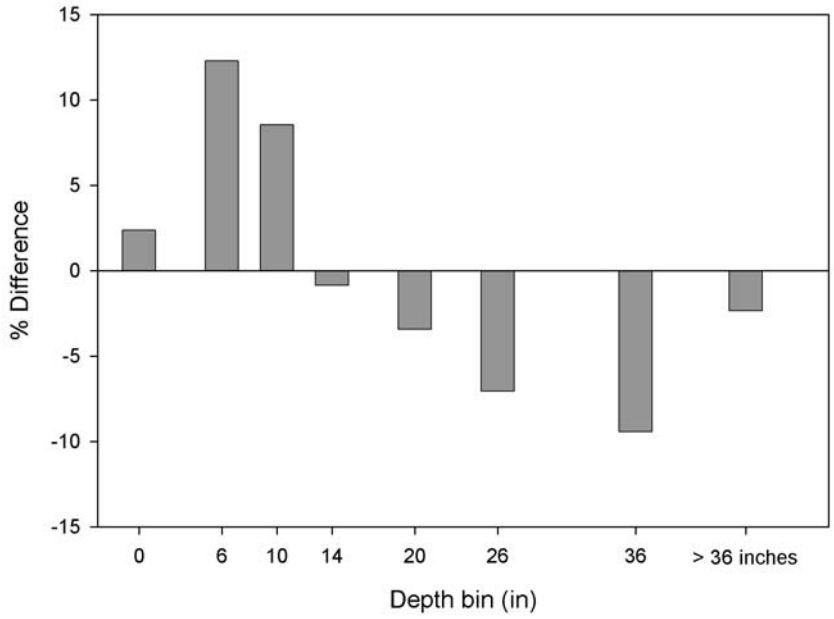

Figure 2. Percent difference in depth categories between Honopou Stream, Maui and all streams statewide in DAR Aquatics Surveys Database. Positive values denote an increase in the percent frequency of a depth category in Honopou Stream as compared to streams statewide. Negative values denote a decrease in the percent frequency of a depth category in Honopou Stream as compared to streams statewide.

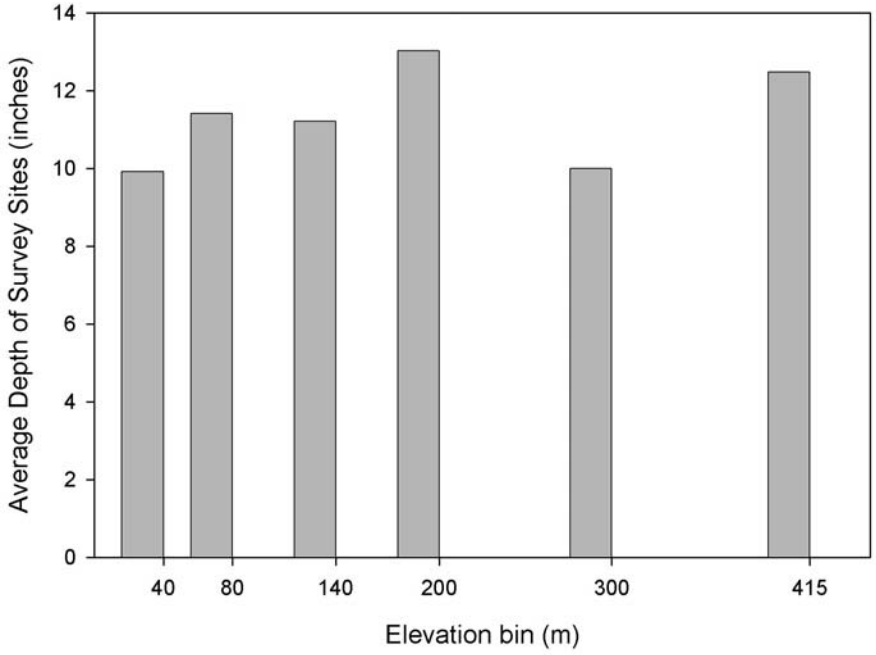

Figure 3. Average depth observed in Point Quadrat Survey Sites for different elevation bins. The elevation bins include all sites up to and including the elevation value. For example, the first bin would include all sites with elevations from 0 to and including 30 m, the second bin would include all sites greater than 30 m to and including 50 m, and so on.

Conclusions:

Although little data was collected for native amphidromous animals in Honopou stream, it did appear that most animals were observed in deeper then average site depths. This general pattern was followed by most of the native fishes and macroinvertebrates observed, except for *Sicyopterus stimpsoni* which was observed in a single shallow site. With the exception of the observation for *Sicyopterus stimpsoni* , the general pattern observed in Honopou Stream was consistent with depth suitability findings for these species statewide suggesting that the native animals in Honopou behave in a fairly typical pattern.

The availability of depths was different in Honopou Stream than observed in streams statewide. The frequency of sampling a site 10 inches in depth or less went from about 3 in 10 sites statewide to more than 1 in 2 sites in Honopou. The availability of very deep sites was also different. In streams statewide sites deeper than 26 inches were sampled in about 15 in 100 sites, while in Honopou Stream sites this deep were uncommonly observed at about 3 in 100 sites.

Field surveyors noted that this stream was mostly continuous and dewatered sections were associated with stream diversions and this is supported by images in the photograph section of this report. When the distribution of average depths were plotted as a function of elevation, little pattern was observed. This stream appears to be shallower on average than a typical Hawaiian stream. The available depths suggest that large sections of the

stream are currently not highly suitable for native animals and this supported by the low numbers of native amphidromous animals observed.

Return of water into Honopou Stream would likely have a beneficial effect on the availability of suitable depths for native species in the currently shallow stream sections. In comparison to other completely dewatered stream in East Maui, Honopou appears to lack the highly suitable deep pools, but is generally deeper than the other streams.

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Section 6: Photographs taken during stream surveys

Estuary

No estuary in this watershed.

Lower Reach

Honopou Stream flows into a boulder beach at the ocean.

Upstream view of large pool near site sh001r-112807

Fence and barb wire placed across stream tributary limited further access in this stream section.

Lower Honopou Stream with boulders & bedrock.

Middle Reach

Middle reach of Honopou stream, Maui, Hawai‘i. 11/28/2007

Auwai for taro lo’i downstream.

Large plunge pool below the three by-pass pipe diversion on Haiku diversion & ditch.

Water flows through three by-pass pipes across the Haiku diversion irrigation ditch. The pipes prevent the upstream movement of native amphidromous animals. An improved design eliminating the pipe overhang with water trickling down a continuous sloping hard surface might provide access upstream with no change in the amount of discharge.

Close up of the three bypass pipes on Haiku diversion.

High flood waters over the irrigation ditch with the three bypass pipes. Note the lack of a simple passage way even at these high flows.

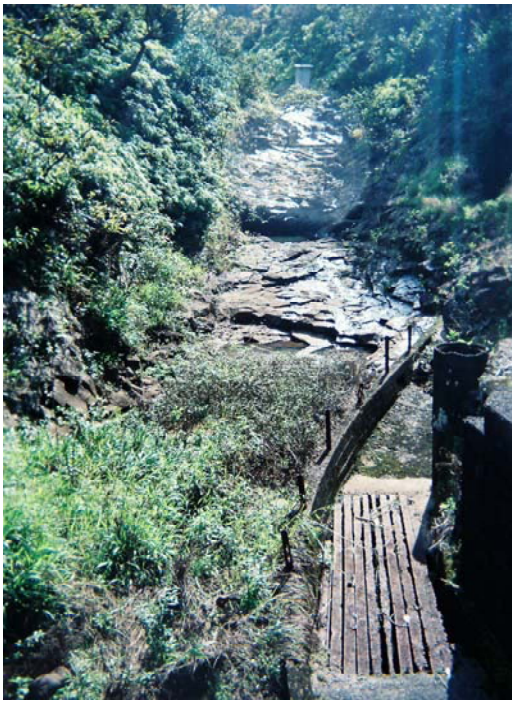
Upstream view of dry waterfall at site gh074r-030508. Note concrete diversion structure (yellow arrow) below fallen tree at the top of the cliff.

Downstream view of diversion just above the dry water valley in the previous photograph. Note the flume gate (yellow oval) in the middle.

Upper Reach

Looking upstream from below the first upper reach diversion on Honopou Stream. Image taken on 3/6/08.

Photo taken downstream, immediately below first diversion. Note the difference in flow from previous photo taken above diversion.



Mostly dry stream bed in the upper reaches of Honopou stream, Maui. Image was close to survey book number gh062n-030608.

Water tunnel (left) in mountain flows into irrigation ditch (right).

Waterfall pool above upper diversion (identified by Hilo staff as first diversion).

Upper reach Honopou Stream, Maui. Taken by Dan Polhemus 5/15/2008

Headwaters

No headwaters reach in this watershed.