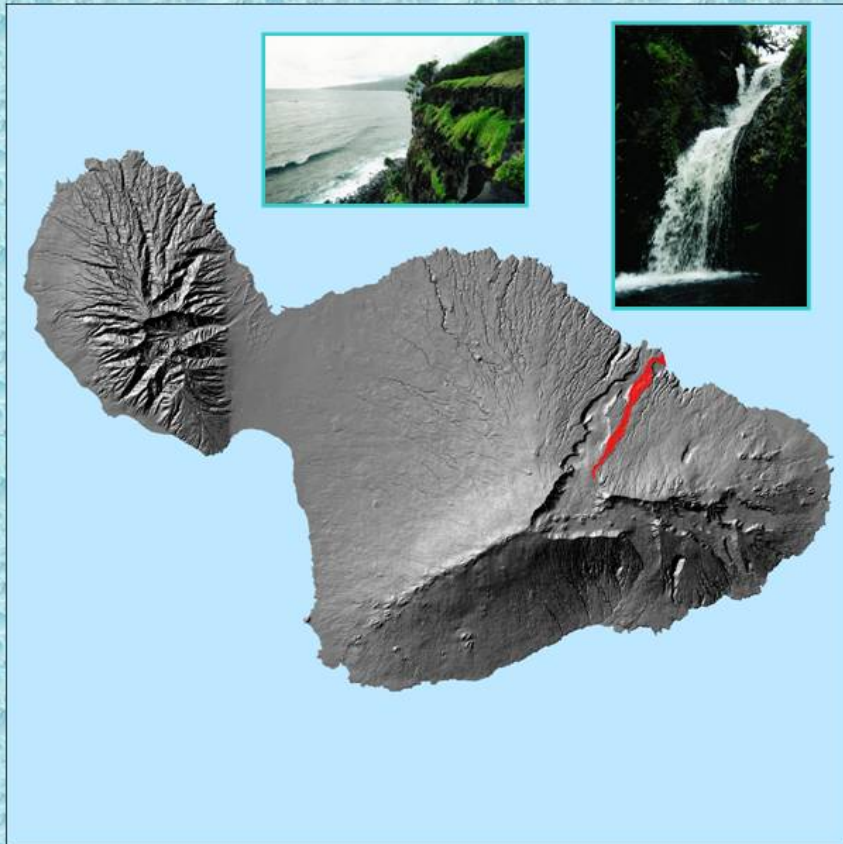


Report on Waiokamilo Stream Maui, Hawaii



June 2008

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



Report on Waiokamilo Stream Maui, Hawai‘i

June 2008

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

Prepared by
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Section 1: Overview

Introduction:

This report is an accounting of the aquatic resources that have been observed in Waiokamilo 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description of the watershed and its aquatic resources from Division of Aquatic Resources (DAR) and other published and unpublished surveys as well as a rating of the condition of the stream compared to other streams on Maui as well as statewide.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 Waiokamilo Stream while also providing substantial evidence to support the conclusions presented.

Findings for Waiokamilo Stream, Maui:

Waiokamilo is a small (2.7 square miles), narrow watershed. It is mostly zoned conservation (83%) and agricultural (17%) and the land cover are mostly evergreen forest (76%), scrub (17%), and grassland (6%). Several stream surveys have been completed in Waiokamilo Stream beginning in 2002 to the present. This watershed rates average in comparison to other watersheds on Maui and statewide. It has a total watershed rating of 7 out of 10, a total biological rating of 3 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*

Crustaceans - *Atyoida bisulcata*

Mollusks – No native mollusks

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

Fish - *Poecilia reticulata*, *Poecilia sp.*, *Gambusia affinis*, *Cyprinus carpio*, and
Misgurnus anguillicaudatus

Crustaceans - *Macrobrachium lar* and *Procambarus clarkii*

Mollusks - *Pomacea canaliculata* and *Physidae*

No aquatic insect surveys were conducted on Waiokamilo Stream.

The native animals were observed using sites with deeper water. Suitable depths for all native species were approximately 20 inches or deeper. This is consistent with findings statewide. The diversions resulted in an increase frequency of dry sites as compared to streams statewide. The distribution of depths in comparison to elevation showed that the stream was shallower downstream of diversions than would be expected in a normal stream. This is likely restricting native adult animal habitat.

Photographs were only taken in the middle reach. There is no lower reach as a result of the terminal waterfall and the upper reaches and headwaters weren't surveyed.

Discussion for Waiokamilo Stream, Maui:

This is an intermittent stream with a terminal waterfall to the ocean. U.S. Geological Survey (USGS) reports that the lower end of the stream is a losing reach. Water is used for irrigation and taro. Water has been directed from this stream to taro patches (lo'i) in Wailua for over a hundred years. This watershed has a moderate total biological rating for Maui and statewide as a result of few native species in comparison to introduced species observed in the stream.

Fish and macroinvertebrates including *Awaous guamensis* and *Atyoida bisulcata*, were observed in the middle reach of this stream. No native mollusks were observed. The presence of *Awaous guamensis* and *Atyoida bisulcata*, both native amphidromous animals, in this stream is a positive sign that some habitat exists although the absence of *Lentipes concolor* suggests that overall habitat for fish in this stream is limited under current flow conditions. In contrast with other streams in the East Maui area, 66 of 93 sites had no animals of any type observed in them. Return of water into Waiokamilo Stream would likely have a beneficial effect on the availability of suitable depths for native species in the currently dewatered stream sections.

The lack of surveys or observations of insects in general and native damselflies in particular is an unknown for this stream. Given the presence of native damselflies in adjacent watersheds, it is possible that they exist in the upper reaches of this stream.

Larval recruitment has not been observed near the terminal section of this stream. Recruitment of postlarvae is likely restricted as there is little or no flow for much of the time at the mouth of this stream. The presence of *Awaous guamensis* and *Atyoida bisulcata* in this stream confirms that some recruitment is occurring. It is hypothesized that the recruitment is only happening during high flow events that completely water the lower stream channel. This stream is mainly diverted for taro irrigation.

Apple Snails were observed in the 1990's although they have not been observed recently. Guppies, mosquitofish, goldfish, and crayfish were observed in the middle reach. 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.

The lower stream reach is almost completely diverted and is directed to Wailua which drains into Wailuanui Stream. At most times there is ~~not~~ insufficient flow to connect to the ocean in its original stream channel. The lack of stream connectivity likely decreases the ~~observed~~ number of adult native amphidromous animals upstream. The combination of a losing stream and stream diversions resulted in decreased habitat and connectivity to the ocean in the lower section of this stream.

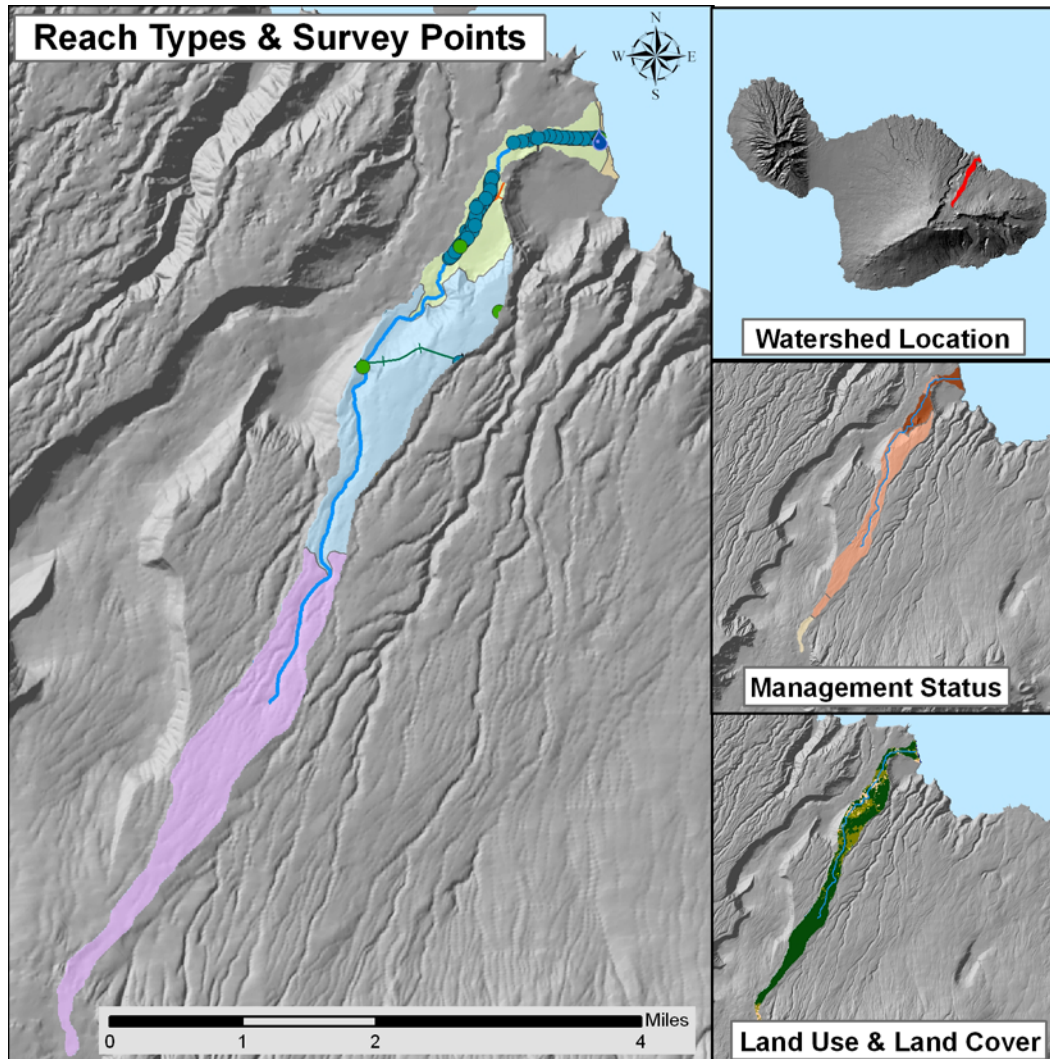
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Section 2: Watershed Atlas Report



DAR Watershed Code: 64013

Waiokamilo, Maui



WATERSHED FEATURES

Waiokamilo watershed occurs on the island of Maui. The Hawaiian meaning of the name is unknown. The area of the watershed is 2.7 square mi (7.1 square km), with maximum elevation of 6486 ft (1977 m). The watershed's DAR cluster code is not yet determined. The percent of the watershed in the different land use districts is as follows: 17.4% agricultural, 82.6% conservation, 0% rural, and 0% urban.

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

<u>Military</u>	<u>Federal</u>	<u>State</u>	<u>OHA</u>	<u>County</u>	<u>Nature Conservancy</u>	<u>Other Private</u>
0.0	0.0	75.9	0.0	0.0	4.3	19.8

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>	Protected but <u>Unprotected</u>
4.3	75.9	0.0	19.8

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	0.0	0.00	0.00
Cultivated	0.0	0.00	0.00
Grassland	6.3	0.17	0.45
Scrub/Shrub	16.7	0.46	1.19
Evergreen Forest	76.1	2.09	5.40
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	0.4	0.01	0.03
Unconsolidated Shoreline	0.0	0.00	0.00
Water	0.3	0.01	0.02
Unclassified	0.0	0.00	0.00

STREAM FEATURES

Waiokamilo is a perennial stream. Total stream length is 5.8 mi (9.3 km). The terminal stream order is 1.

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

<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
0.0	0.4	40.8	39.4	19.4

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

BIOTIC SAMPLING EFFORT

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

1979	2002	2003	2007
------	------	------	------

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

<u>Survey type</u>	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
DAR Point Quadrat	0	0	98	0	0
DAR Rapid BioAssessment	0	1	10	0	0
Published Report	0	2	1	1	0

BIOTA INFORMATION**Species List****Native Species**

Crustaceans	<i>Atyoida bisulcata</i>
Fish	<i>Awaous guamensis</i> <i>Lentipes concolor</i>

Introduced Species

Amphibians	<i>Bufo marinus</i> <i>Ranidae sp.</i>
Crustaceans	<i>Macrobrachium lar</i> <i>Procambarus clarkii</i>
Fish	<i>Carassius auratus</i> <i>Cyprinus carpio</i> <i>Gambusia affinis</i> <i>Misgurnus anguillicaudatus</i> <i>Poecilia reticulata</i> <i>Poeciliidae sp.</i> <i>unidentified poeciliidae</i>
Snails	<i>Physidae sp.</i> <i>Pomacea canaliculata</i>

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	
<i>Lentipes concolor</i>	Endemic		P			
<i>Awaous guamensis</i>	Indigenous			P		
<i>Bufo marinus</i>	Introduced			P		
<i>Ranidae sp.</i>	Introduced			P		
<i>Ranidae sp.</i>	Introduced			P		
<i>Ranidae sp.</i>	Introduced			P		
<i>Macrobrachium lar</i>	Introduced			P		
<i>Procambarus clarkii</i>	Introduced			P		
<i>Carassius auratus</i>	Introduced			P		

<i>Cyprinus carpio</i>	Introduced	P	
<i>Gambusia affinis</i>	Introduced		P
<i>Misgurnus anguillicaudatus</i>	Introduced	P	
<i>Poecilia reticulata</i>	Introduced	P	P
<i>Poeciliidae sp.</i>	Introduced	P	
<i>unidentified poeciliidae</i>	Introduced		P
<i>Physidae sp.</i>	Introduced	P	P
<i>Pomacea canaliculata</i>	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.

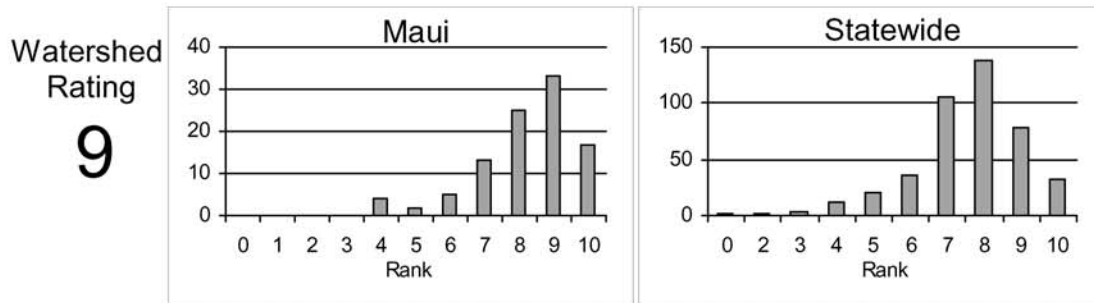
Native Insect Diversity <u>> 19 spp.</u>	Native Macrofauna <u>Diversity > 5 spp.</u>	Absence of Priority 1 <u>Introduced</u>
No	No	No
Abundance of Any <u>Native Species</u>	Presence of Candidate <u>Endangered Species</u>	Endangered Newcomb's <u>Snail Habitat</u>
No	No	No

CURRENT WATERSHED AND STREAM RATINGS

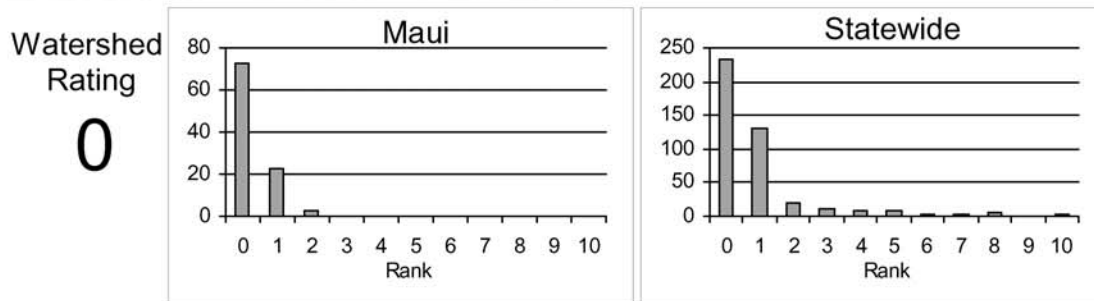
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding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

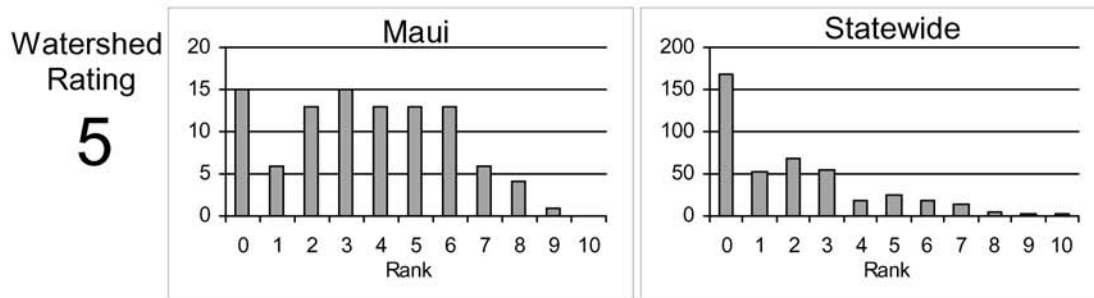
Land Cover Rating: Rating is based on a scoring system where in general forested lands score positively and developed lands score negatively.



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



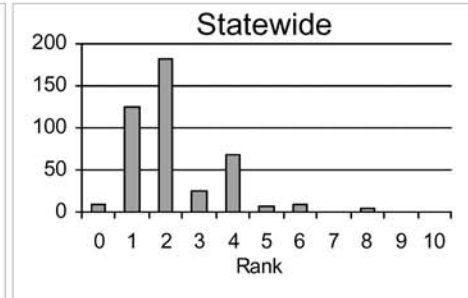
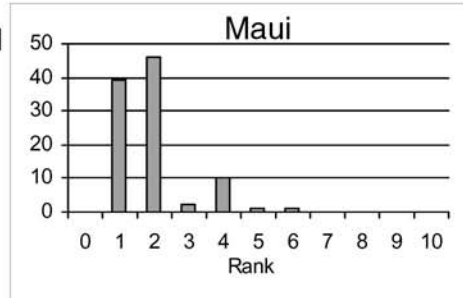
Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.



WATERSHED RATING (Cont): Waiokamilo, Maui

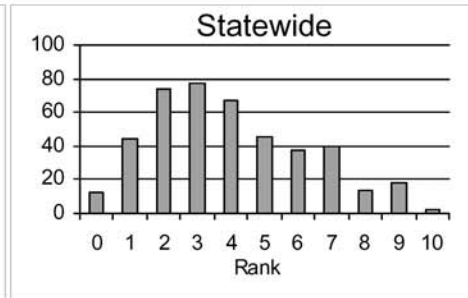
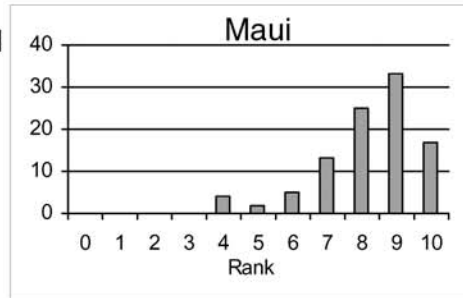
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.

Watershed Rating
1



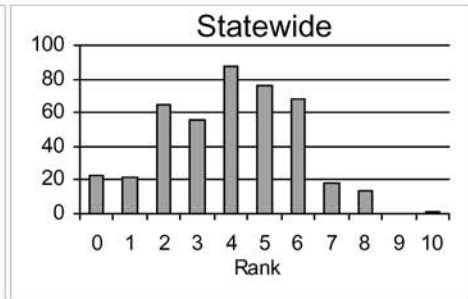
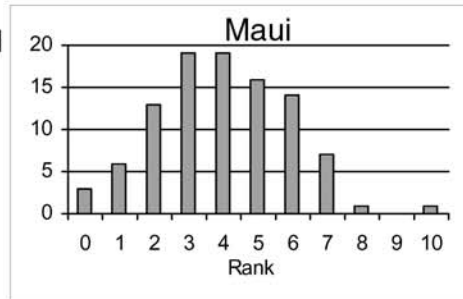
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.

Watershed Rating
8



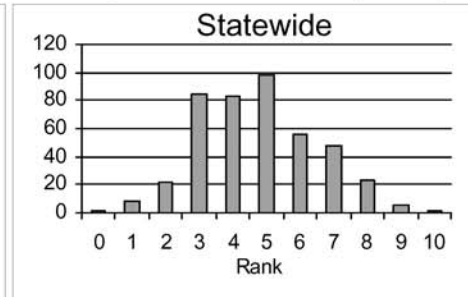
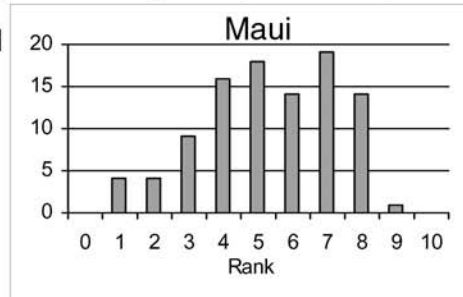
Reach Diversity Rating: Rating is based on the types and amounts of different stream reaches available in the watershed. More area in different reach types score more positively.

Watershed Rating
5



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

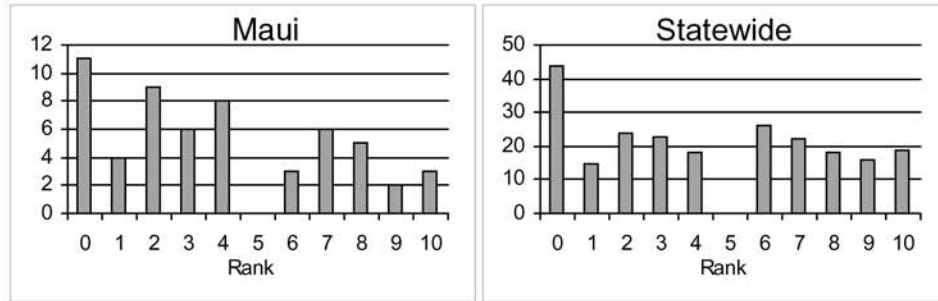
Watershed Rating
7



BIOLOGICAL RATING: Waiokamilo, Maui

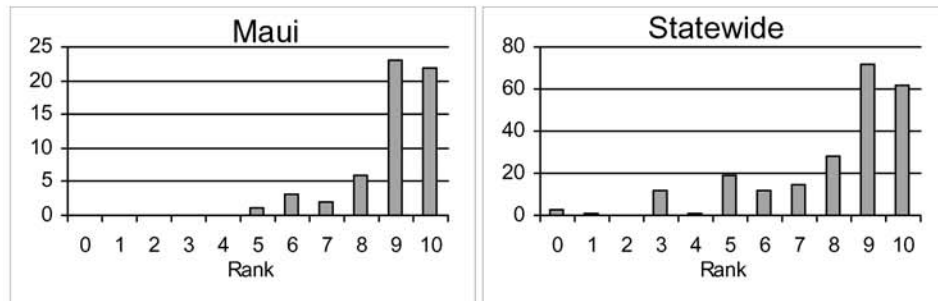
Native Species Rating: Rating is based on the number of native species observed in the watershed.

Stream Rating
2



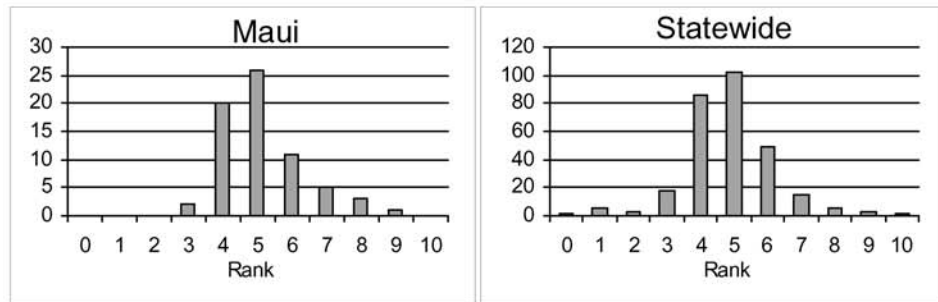
Introduced Genera Rating: Rating is based on the number of introduced genera observed in the watershed.

Stream Rating
8



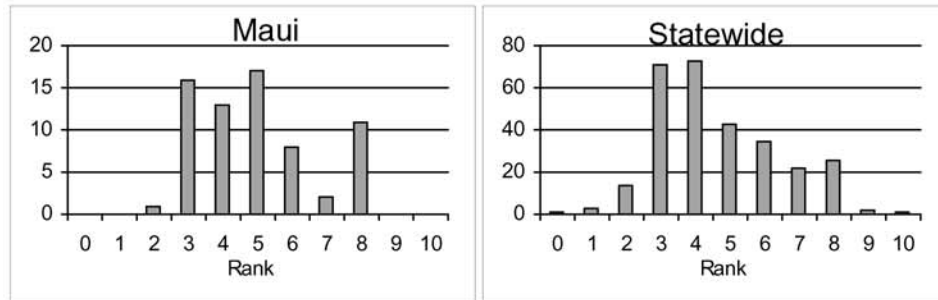
All Species' Score Rating: Rating is based on the Hawaii Stream Assessment scoring system where native species score positively and introduced species score negatively.

Stream Rating
3



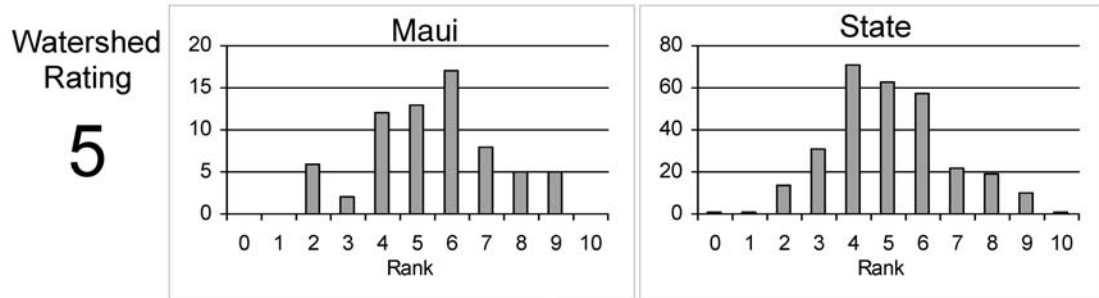
Total Biological Rating: Rating is the combination of the Native Species Rating, Introduced Genera Rating, and the All Species' Score Rating.

Stream Rating
3



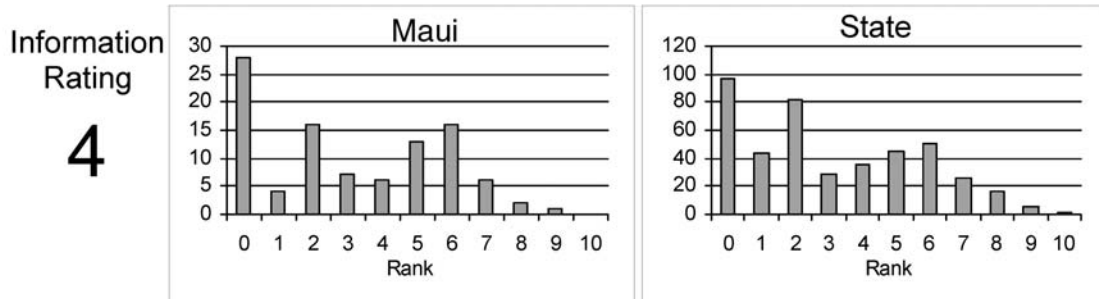
OVERALL RATING: Waiokamilo, Maui

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



RATING STRENGTH: Waiokamilo, Maui

Rating Strength: Represents an estimate of the overall study effort in the stream and is a combination of the number of studies, number of different reaches surveyed, and the number of different survey types.



REFERENCES

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

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

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

Appendix 1: Scientific and Common Names

Appendix 1: Scientific and Common Names (continued)

CN = Common Name and HN = Hawaiian Name

Amphibian

Introduced

Bufo marinus

CN: marine toad; HN: none.

Ranidae

CN: none; HN: none.

Ranidae

CN: unidentified frog; HN: none.

Ranidae

CN: unidentified frog tadpole; HN: none.

Crustacean

Endemic

Atyoida bisulcata

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

Introduced

Macrobrachium lar

CN: none; HN: none.

Procambarus clarkii

CN: red swamp crayfish; HN: none.

Fish

Endemic

Lentipes concolor

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

Indigenous

Awaous guamensis

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

Introduced

Carassius auratus

CN: Goldfish; HN: none.

Cyprinus carpio

CN: Common carp (AFS), Carp (DLNR), Koi; HN: none.

Gambusia affinis

CN: Western mosquitofish; HN: none.

Misgurnus anguillicaudatus

CN: Oriental weatherfish (AFS), Dojo, Weather loach (Yamamoto & Tagawa, 2000); HN: none.

Poecilia reticulata

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

Appendix 1: Scientific and Common Names (continued)

CN = Common Name and HN = Hawaiian Name

Poeciliidae

CN: unidentified livebearers; HN: none.

unidentified poeciliidae

CN: unidentified molly; HN: .

Snail

Introduced

Physidae

CN: none; HN: none.

Pomacea canaliculata

CN: none; HN: none.

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Section 3: DAR Point Quadrat Survey Report

Results of DAR Point Quadrat Survey Report for Hanehoi Stream, Maui for Surveys from 5/2/2002 to 5/2/2002

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:

Waiokamilo (ID: 64013), Ke‘anae, Maui

Table 2. Survey Team Personnel:

Hau, Skippy
 Higashi, Glenn
 Kuamoo, Darrell
 Leonard, Jason
 Nishimoto, Robert
 Young, Rodney

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

<u>Survey Type</u>	<u>Reaches</u>				<u>Total</u>
	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper Headwater</u>	
Point Quadrat (random)			98		98

Middle Reach of Waiokamilo stream, Maui:

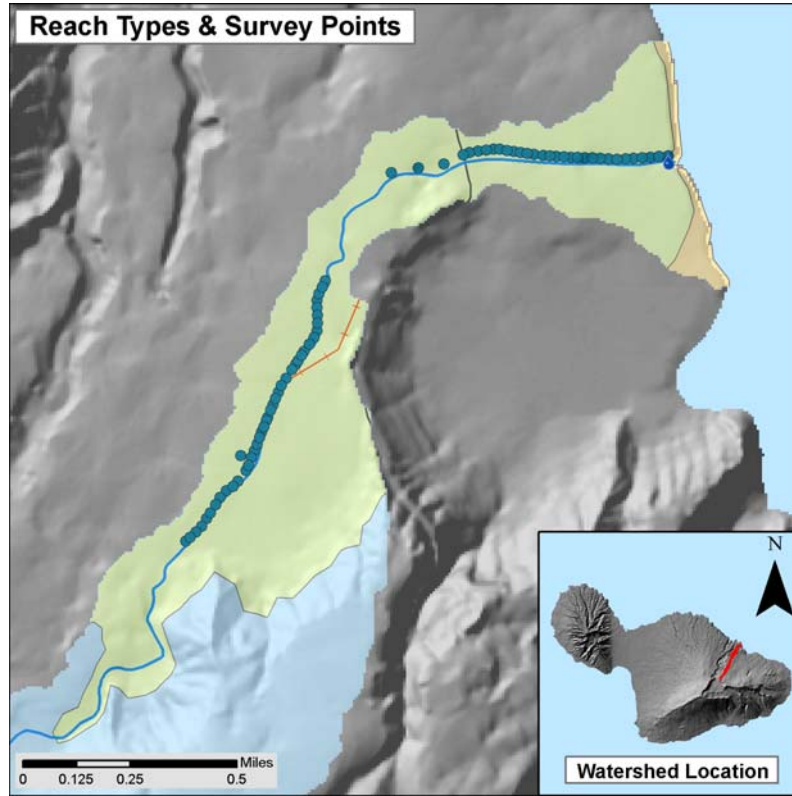


Figure 1. Location of the Point Quadrat Surveys done in the middle reach of Waiokamilo Stream. Green area is the middle reach delineation and blue dots are the surveys.

Habitat Types

<u>Cascade</u>	<u>Riffle</u>	<u>Run</u>	<u>Pool</u>	<u>Plunge</u>	<u>Side pool</u>	<u>No water</u>
3	4	37	27	4	5	13

Substrate Types in Surveys (%)

<u>Detritus</u>	<u>Sediment</u>	<u>Sand</u>	<u>Gravel</u>	<u>Cobble</u>	<u>Boulder</u>	<u>Bedrock</u>
5	3	6	13	17	12	44

Species Observed in the middle reach of Waiokamilo Stream

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg Density</u>	<u>Total # observed</u>
Amphibian	Introduced	<i>Bufo marinus</i>	Middle	0.05	2
Amphibian	Introduced	<i>Ranidae</i>	Middle	0.26	10
Crustacean	Introduced	<i>Procambarus clarkii</i>	Middle	0.03	1
Crustacean	Introduced	<i>Macrobrachium lar</i>	Middle	0.41	16
Crustacean	Endemic	<i>Atyoida bisulcata</i>	Middle	1.05	41

DAR Point Quadrat Survey Report

Waiokamilo, Maui

Fish	Introduced	<i>Carassius auratus</i>	Middle	0.26	10
Fish	Introduced	<i>Gambusia affinis</i>	Middle	0.05	2
Fish	Introduced	<i>Poecilia reticulata</i>	Middle	0.31	12
Fish	Indigenous	<i>Awaous guamensis</i>	Middle	0.03	1
Snail	Introduced	<i>Physidae</i>	Middle	0.03	1
Snail	Introduced	<i>Pomacea canaliculata</i>	Middle	0.08	3

Section 4: DAR Aquatic Insect Report

No recent DAR aquatic insect surveys were performed in Waiokamilo Stream.

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

Methods:

All data reflected in this report came from the DAR Aquatics Surveys Database. For each random survey site in Waiokamilo Stream, Maui (Watershed code: 64013) 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 Waiokamilo Stream and for all sites statewide in the DAR Point Quadrat Surveys. Additionally, the difference between the percent frequencies for each depth bin was 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 for native amphidromous animals to develop depth suitability criteria. In the random point quadrats, 8 of 93 sites with *Atyoida bisulcata* were observed with an average depth of 16.5 inches, one site with *Awaous guamensis* were observed at a depth of 13 inches. In contrast with other streams in the East Maui area, 66 of 93 sites had no animals of any type observed and these sites averaged 11.6 inches in depth.

The pattern of the distribution of observed depths in Waiokamilo Stream in comparison to the statewide average depths reveals that dry sites are much more common in Waiokamilo than in most Hawaiian Streams (Figure 1). The sample size was 93 sites for Waiokamilo Stream in comparison to 6084 sites statewide. There were approximately 14% more dry sites than observed in the statewide data set (Figure 2). In contrast to the increase in dry sites, there was a decrease in most depth bins 14 inches depth or deeper.

When observing the distribution of average depth as a function of elevation, the depths increased in the higher elevations and then decreased at lower elevations (Figure 3). The elevations bin between 70 and 120 m had an average site depth of almost 15 inches, while the elevation bin less than 40 m had an average site depth of 9 inches.

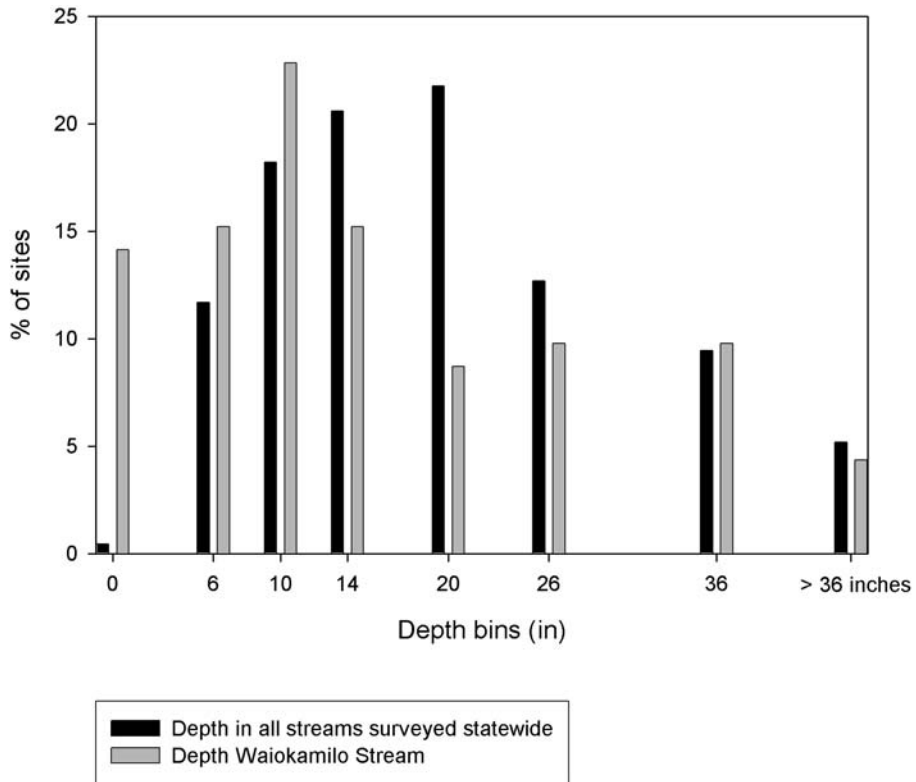


Figure 1. Comparison of percent availability for depth categories between Waiokamilo Stream, Maui and all streams statewide in the DAR Aquatics Surveys Database.

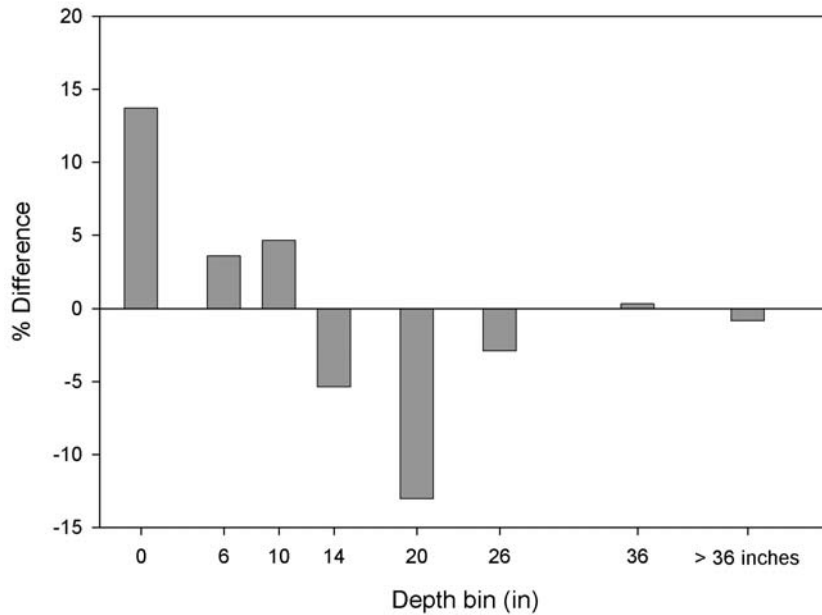


Figure 2. Percent difference in depth categories between Waiokamilo Stream, Maui and all streams statewide in DAR Aquatics Surveys Database. Positive values denote an increase in the percent frequency of a depth category in Waiokamilo Stream as compared to streams statewide. Negative values denote a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

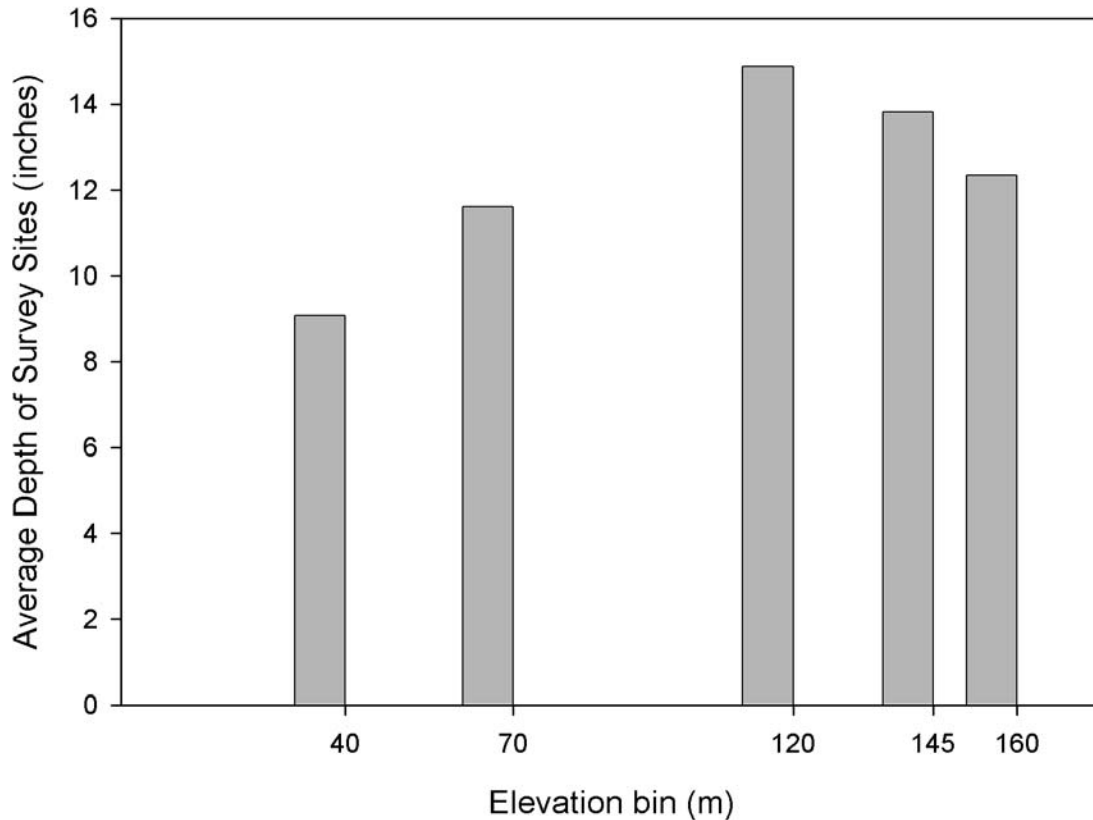


Figure 3. Average depth observed in Point Quadrat Survey Sites for different elevation bins. The elevation bins include all sites up to and including the elevation value. For example, the first bin would include all sites with elevations from 0 to and including 30 m, the second bin would include all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

Conclusions:

Native and introduced animals were not commonly observed in Waiokamilo Stream. *Atyoida bisulcata* were observed in sites with deeper than average water, but many sites with adequate water depth were uninhabited. This is different than the other streams in East Maui we surveyed, and may be an indication that the unconnected lower section of the stream is preventing most upstream migration, or maybe there are water quality issues in this stream that we did not test for.

The availability of suitable depths was quite different in Waiokamilo Stream than in other streams statewide. The frequency of sampling a dry site went from about 1 in 200 sites statewide to more than 1 in 7 sites in Waiokamilo. Field surveyors noted that the native animals were restricted to disconnected deep pools in an otherwise dry stream bed in the lower sections of the stream. In sections where water still flowed, the stream animals were observed in a wider range of habitats.

When the distribution of average depths was plotted as a function of elevation, a pattern of decreasing depths toward the downstream end of the stream was observed. While this pattern is not conclusive that all water lost from the stream as it flows downstream is associated with water diversions, it does suggest that large sections of stream are currently unsuitable for native animals.

Return of water into Waiokamilo Stream would likely have a beneficial effect on availability of suitable depths for native species in currently dewatered stream sections. Additionally, the return of water into Waiokamilo Stream would increase stream connectivity with the ocean aiding in the upstream migration of native animals.

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Section 6: Photographs taken during stream surveys

Estuary:

No estuary on this stream. Terminal waterfall goes into the ocean.

Lower Reach:

No aquatic insect or point quadrat surveys were performed. Lower reach is below terminal waterfall on the rocks.



View of cobble and boulder beach below the terminal waterfall.



View of cobble/boulder beach in the lower reach below the terminal waterfall which is the delineation for the middle reach. Note water seeping from the wall (yellow oval).

Middle Reach:



Waiokamilo Stream with its intermittent terminal waterfall next to ocean.



Downstream view Waiokamilo Stream just above terminal waterfall. Note standing pools.



Waiokamilo Stream above Hana Highway bridge.



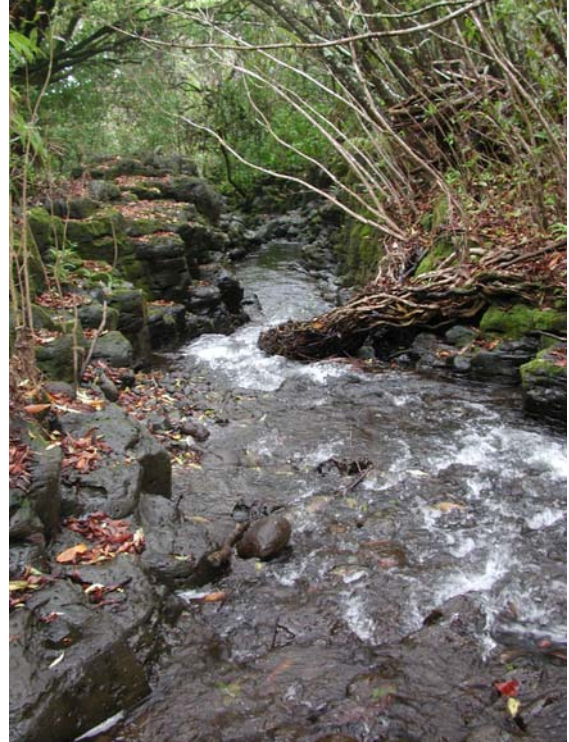
Water partially diverted in stream for taro patch (lo'i) from Waiokamilo Stream.



Partial diversion of water from Waiokamilo Stream.



Run habitat in Waiokamilo Stream.



Waiokamilo Stream with vegetation canopy



Hau, *Hibiscus tiliaceus*, encroachment into flood channel of Waiokamilo Stream.



Waiokamilo Stream opens up where taro patches (lo'i) were previously established; Removal of hau, *Hibiscus tiliaceus*, from adjoining areas



Upstream view of concrete dam on Waiokamilo Stream showing areas where the hau, *Hibiscus tiliaceus*, are cut back.

Photographs of stream surveys

Waiokamilo, Maui

Upper Reach:

No aquatic insect or point quadrat surveys were performed.

Headwaters:

No aquatic insect or point quadrat surveys were performed.