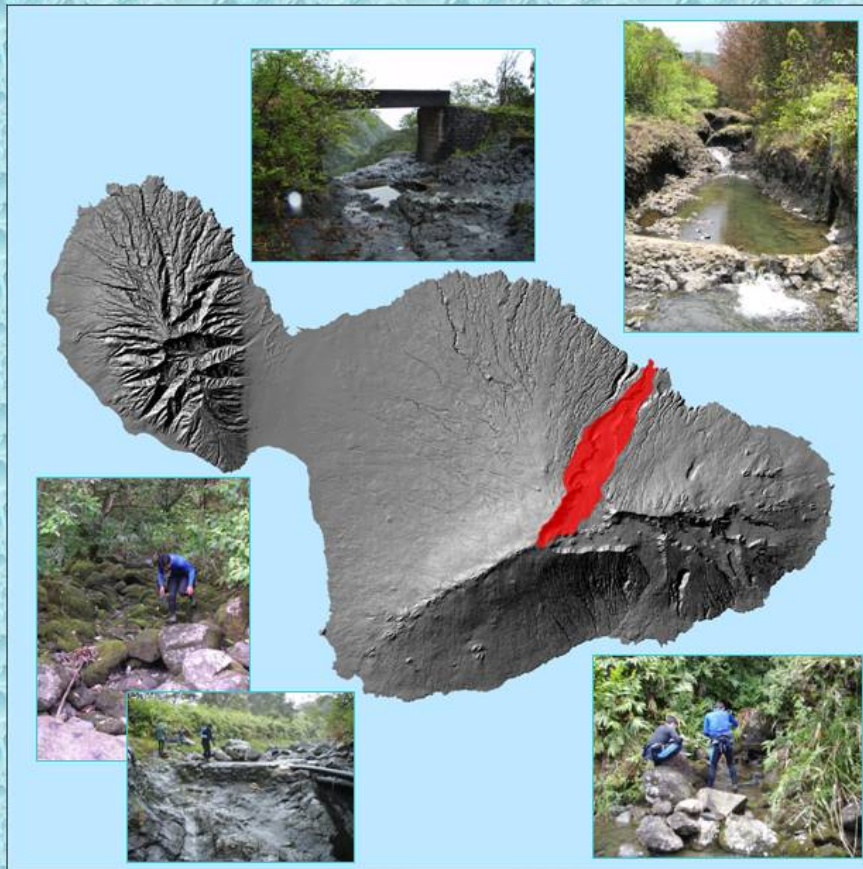


Report on Pi'ina'au Stream Maui, Hawaii



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

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Section 1: Overview

Introduction:

This report is an accounting of the aquatic resources that have been observed in Pi'ina'au Stream, Maui. The report was generated to provide information to aid in the instream flow determination for the East Maui Streams at the request of the Commission on Water Resource Management. 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description of the watershed and its aquatic resources from Division of Aquatic Resources (DAR) and other published and unpublished surveys as well as a rating of the condition of the stream compared to other streams on Maui as well as statewide.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 Pi'ina'au Stream while also providing substantial evidence to support the conclusions presented.

Findings for Pi'ina'au Stream, Maui:

Pi'ina'au is a large (20.5 sq miles), narrow watershed that is steep in the upper sections. It is mostly zoned conservation (97%) and the land cover is mostly evergreen forest (51%), scrub (22%), bare land (15%), and grassland (12%). Numerous stream surveys of different types have been completed in Pi'ina'au stream beginning in 1962 to the present. This watershed rates high in comparison to other watersheds in Maui and statewide. It has a total watershed rating of 8 out of 10, a total biological rating of 8 out of 10, and a combined overall rating of 9 out of 10.

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

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

Crustaceans - *Atyoida bisulcata* and *Macrobrachium grandimanus*

Mollusks - *Ferrissia sharpi*, *Neritina granosa*, and *Neritina vespertina*

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

Fish - *Poecilia reticulata*

Crustaceans - *Macrobrachium lar*

Mollusks - *Corbicula fluminea*, *Musculium partumieum*, *Pisidium sp.*, *Lymnea sp.*,
Physidae, *Pomacea canaliculata* and *Thiarid sp*

Also observed in this watershed is the listed as candidate for endangered species native damselfly, *Megalagrion pacificum*. Two other native damselfly species were also observed; *Megalagrion blackburni* and *Megalagrion nigrohamatum nigrohamatum*

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 the diversions then would be expected in a normal stream. The lack of suitable depths likely restricts native adult animal habitat in some stream sections.

Photographs were taken of interesting features of stream habitat and diversions. Photographs show that dry sections exist downstream of diversions. The diversions are extensive and include the transfer of water downstream in polyvinyl chloride (pvc) pipes. The photographs also show a range of habitat from deep channel stream sections to more open stream channel sections.

Discussions

Pi'ina'au stream is one of the largest streams in this area of concern and has a very wide variety of habitats and stream channel morphology. There are some issues in this watershed with sedimentation and erosion due to agricultural clearing and cattle ranching are present. Hau, *Hibiscus tiliaceus*, overgrowth is also a problem because of the reduction in water velocities as witnessed on other islands statewide.

Pi'ina'au Stream and its watershed rate highly when compared to other streams on Maui and statewide. This suggests that Pi'ina'au Stream has the potential to be a high quality stream that contains substantial habitat for a wide range of native animals. We observed most native animals in the stream, although current conditions appear to result in much lower numbers on animals than the stream potentially could contain.

The watershed for Pi'ina'au stream contains Waialohe pond which is the largest estuarine pond surveyed on the island of Maui. Palauhulu (a tributary of Pi'ina'au) and Pi'ina'au streams join above Waialohe Pond which flows to the ocean during moderate flows. Depending upon large ocean swells, a berm of sand and boulders often blocks water from flowing into the ocean.

All expected native fish and macroinvertebrates were observed in the stream. The pond provides habitat for a number of native estuarine animals. Native animals were observed in higher numbers than any of the five targeted East Maui streams (Honopou, Hanehoi, Pi'ina'au, Waiokamilo, and Wailuanui). Mountain shrimp, *Atyoides bisulcata*, were present in high numbers in some locations in upper reach of this stream.

Larval recruitment has been monitored on the terminal waterfall above Waialohe Pond. Skippy Hau, DAR, has observed and collected postlarvae recruits on the waterfall face. All native species postlarvae including, 'o'opu 'alamo'o, *Lentipes color* have been collected at this site near the mouth of Pi'ina'au Stream. Although postlarval recruitment is occurring, the design of diversion intakes limits upstream movement under normal flow conditions.

Possible competition exists between the native stream animals and some introduced animals. Mosquitofish, *Gambusia affinis*, apple snails, *Pomacea canaliculata* and asiatic clams, *Corbicula fluminea* have become established in the irrigation ditches, on the Ke'anae peninsula. Live and dead clams have been collected and removed from Palauhulu Stream beneath the highway bridge. Mosquitofish are known to harbor parasites and may introduce them to native fish populations. In this stream, high flows typically reduce or eliminate the population of introduced animals in the stream, although they are likely reintroduced to the stream from the ditch populations.

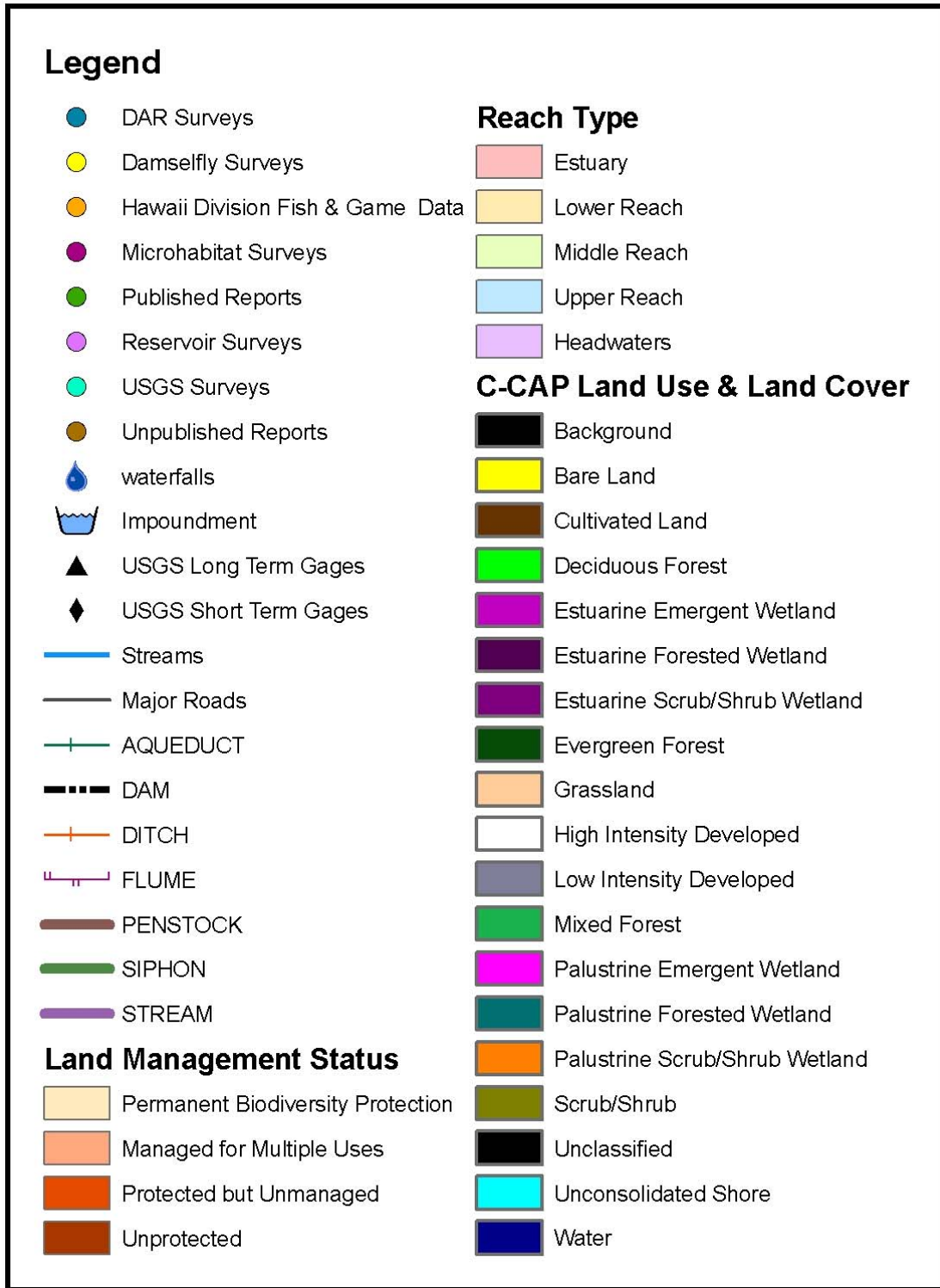
During periods of higher rainfall the upstream diversions are overtopped and stream flow is continuous to the ocean. During these periods, larval recruitment can occur and upstream migration is possible. When the rains end, the diversions quickly remove lower flows resulting in dewatered sections of the stream preventing upstream migration of native stream animals and results in newly arriving recruits being stranded at the stream mouth.

High flow events allow some movement of animals in the stream and are likely responsible for the small number of adults found in the disconnected deeper pools in middle and upper stream reach. When rainfall ends, the diversions dewater or reduce flow causing the loss of habitat such as runs and riffles and restricting the surviving animals to only deep pools.

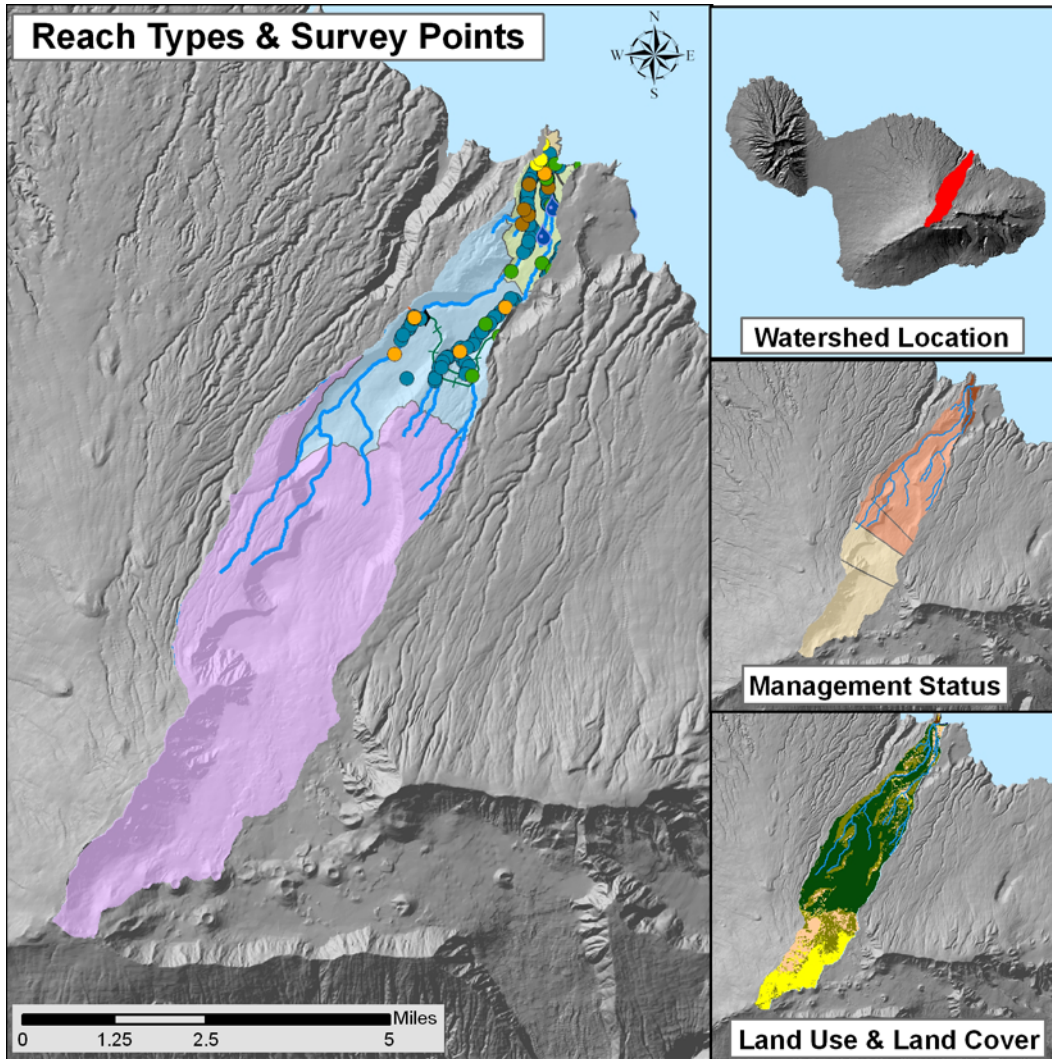
This stream has multiple diversions connected to several different levels of ditches and the flume which provides water for taro patches (lo'i) on the peninsula. The diversions connected to the irrigation ditches remove the total stream flow prohibiting larval recruitment and downstream larval dispersal at normal or moderate flows. For example, larval recruits can move upstream past a concrete weir (see Section 6: Photographs, lower reach) which "partially" diverts water from Palauhulu Stream for taro patches (lo'i). This is in contrast to the upper diversions which span the total width and divert all

of the water. The diversion gratings don't allow water to pass downstream thereby preventing migration. In addition to the issues with larval migration, the ditches also remove a substantial amount of water which limits the amount of adult native animal habitat in the stream. DAR surveys were not intended to document all diversions and only diversions within our survey area are noted. There may be additional diversions that were not observed that may exist outside of our survey areas. In addition to the loss of flow and habitat, the water temperature is higher.

Section 2: Watershed Atlas Report



Pi'ina'au, Maui



WATERSHED FEATURES

Pi'ina'au watershed occurs on the island of Maui. The Hawaiian meaning of the name is unknown. The area of the watershed is 20.5 square mi (53.2 square km), with maximum elevation of 10007 ft (3050 m). The watershed's DAR cluster code is 6, meaning that the watershed is large, narrow, and steep in the upper watershed. The percent of the watershed in the different land use districts is as follows: 3% agricultural, 97% 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</u>	<u>Private</u>
0.0	26.8	54.0	0.0	0.0	16.1		3.1

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

Permanent Biodiversity <u>Protection</u>	Managed for Multiple <u>Uses</u>	Protected but <u>Unmanaged</u>	<u>Unprotected</u>
42.9	54.0	0.0	3.1

Land Use: Areas of the various categories of land use. These data are based on NOAA C-CAP remote sensing project.

	<u>Percent</u>	<u>Square mi</u>	<u>Square km</u>
High Intensity Developed	0.0	0.00	0.00
Low Intensity Developed	0.1	0.03	0.07
Cultivated	0.2	0.05	0.13
Grassland	11.8	2.43	6.29
Scrub/Shrub	22.1	4.53	11.73
Evergreen Forest	50.7	10.41	26.96
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	14.9	3.06	7.92
Unconsolidated Shoreline	0.0	0.01	0.02
Water	0.1	0.01	0.03
Unclassified	0.0	0.00	0.00

STREAM FEATURES

Pi'ina'au is a perennial stream. Total stream length is 24.2 mi (39 km). The terminal stream order is 3.

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

<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
0.0	1.6	24.0	42.5	31.8

The following stream(s) occur in the watershed:

Hau'oliwahine	Kano	Kuo	Palauhulu	Pi'ina'au
Pokakaekane				

BIOTIC SAMPLING EFFORT

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

1962	1967	1979	1980	1990	1991	1992
1993	1994	1995	1996	2000	2002	2003
2007	2008					

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

<u>Survey type</u>	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
Damselfly Surveys	0	2	0	0	0
DAR General Surveys	0	13	27	0	0
DAR Point Quadrat	0	6	99	57	0
HDFG	0	0	2	4	0
Published Report	1	2	9	3	0
Unpublished Report	0	0	5	0	0

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

Crustaceans	<i>Amphipoda sp.</i> <i>Atyoida bisulcata</i> <i>Macrobrachium grandimanus</i>
Fish	<i>Awaous guamensis</i> <i>Eleotris sandwicensis</i> <i>Gobiidae sp.</i> <i>Kuhlia sp.</i> <i>Kuhlia xenura</i> <i>Lentipes concolor</i> <i>Sicyopterus stimpsoni</i> <i>Stenogobius hawaiiensis</i>
Snails	<i>Neritina granosa</i> <i>Neritina vespertina</i>

Native Species

Insects	<i>Anax junius</i> <i>Anax sp.</i> <i>Anax strenuus</i> <i>Megalagrion blackburni</i> <i>Megalagrion nigrohamatum nigrohamatum</i> <i>Megalagrion pacificum</i> <i>Megalagrion sp.</i> <i>Telmatogeton sp.</i>
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Introduced Species

Amphibians	<i>Rana catesbiana</i> <i>Ranidae sp.</i>
Clams	<i>Corbicula fluminea</i> <i>Musculium partumieum</i> <i>Pisidium sp.</i>
Crustaceans	<i>Macrobrachium lar</i>
Fish	<i>Poecilia reticulata</i>
Snails	<i>Lymnea sp.</i> <i>Physidae sp.</i> <i>Pomacea canaliculata</i> <i>Thiarid sp.</i>

Introduced Species

Insects	<i>Chironomid larvae</i>
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**Average Density: The densities (#/square yard) for species observed in DAR Point
Quadrat Surveys averaged over all sample dates in each reach type.**

<u>Scientific Name</u>	<u>Status</u>	<u>Estuary</u>	<u>Low</u>	<u>Mid</u>	<u>Upper</u>	<u>Headwaters</u>
<i>Anax strenuus</i>	Endemic				0.03	
<i>Atyoida bisulcata</i>	Endemic				1.54	
<i>Lentipes concolor</i>	Endemic			0.52		
<i>Megalagrion blackburni</i>	Endemic				0.03	
<i>Megalagrion nigrohamatum</i>	Endemic				0.07	
<i>Megalagrion sp.</i>	Endemic				0.3	
<i>Neritina granosa</i>	Endemic		3.35	2.32		
<i>Sicyopterus stimpsoni</i>	Endemic		0.74	0.15	0.03	
<i>Awaous guamensis</i>	Indigenous		1.12	0.75		
<i>Macrobrachium lar</i>	Introduced		0.37	0.25	0.03	
<i>Ranidae sp.</i>	Introduced				0.07	

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

<u>Scientific Name</u>	<u>Status</u>	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwaters</u>
<i>Atyoida bisulcata</i>	Endemic		P	P	P	
<i>Macrobrachium</i>	Endemic		P			
<i>Eleotris sandwicensis</i>	Endemic		P			
<i>Kuhlia xenura</i>	Endemic		P			
<i>Lentipes concolor</i>	Endemic	P	P	P	P	
<i>Sicyopterus stimpsoni</i>	Endemic	P	P	P		
<i>Stenogobius hawaiiensis</i>	Endemic		P			
<i>Anax strenuus</i>	Endemic				P	
<i>Megalagrion blackburni</i>	Endemic				P	
<i>Megalagrion nigrohamatum</i> <i>nigrohamatum</i>	Endemic				P	
<i>Megalagrion pacificum</i>	Endemic		P			
<i>Megalagrion sp.</i>	Endemic			P	P	
<i>Neritina granosa</i>	Endemic		P	P		
<i>Neritina vespertina</i>	Endemic		P			
<i>Amphipoda sp.</i>	Indigenous				P	
<i>Awaous guamensis</i>	Indigenous		P	P		
<i>Gobiidae sp.</i>	Indigenous		P	P	P	
<i>Kuhlia sp.</i>	Indigenous		P			
<i>Anax junius</i>	Indigenous				P	
<i>Anax sp.</i>	Indigenous		P		P	
<i>Telmatogeton sp.</i>	Indigenous			P	P	

Watershed Atlas Report

Pi'ina'au, Maui

<i>Telmatogeton sp.</i>	Indigenous		P	P
<i>Rana catesbiana</i>	Introduced	P		
<i>Ranidae sp.</i>	Introduced			P
<i>Corbicula fluminea</i>	Introduced		P	
<i>Macrobrachium lar</i>	Introduced	P	P	P
<i>Poecilia reticulata</i>	Introduced	P		
<i>Chironomid larvae</i>	Introduced		P	P
<i>Lymnea sp.</i>	Introduced	P		
<i>Physidae sp.</i>	Introduced		P	P
<i>Thiarid sp.</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): Outstanding
- U.S. Fish and Wildlife Service High Quality Stream (1988): Yes
- The Nature Conservancy- Priority Aquatic Sites (1985): No
- National Park Service - Nationwide Rivers Inventory (1982): No

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

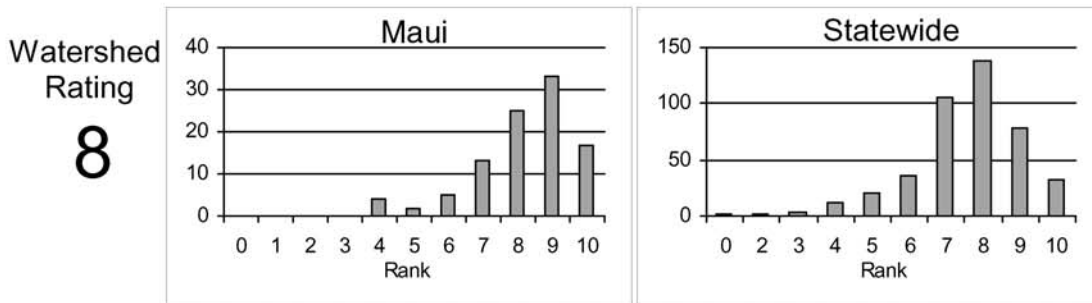
Native Insect Diversity <u>> 19 spp.</u>	Native Macrofauna <u>Diversity > 5 spp.</u>	Absence of Priority 1 <u>Introduced</u>
No	Yes	No
Abundance of Any <u>Native Species</u>	Presence of Candidate <u>Endangered Species</u>	Endangered Newcomb's <u>Snail Habitat</u>
No	Yes	No

CURRENT WATERSHED AND STREAM RATINGS

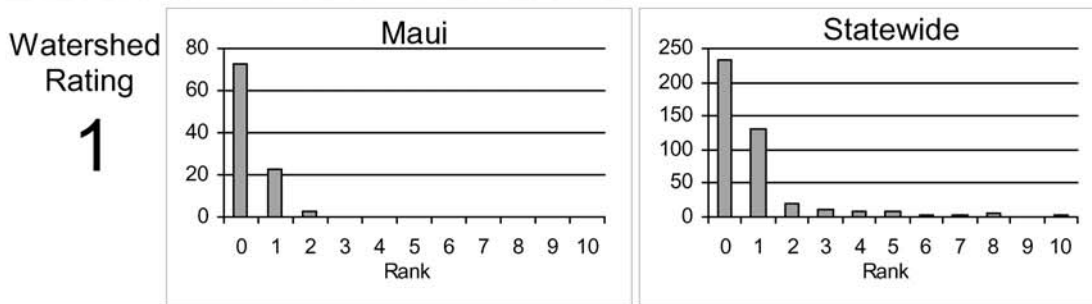
The current watershed and stream ratings are based on the data contained in the DAR Aquatic Surveys Database. The ratings provide the score for the individual watershed or stream, the distribution of ratings for that island, and the distribution of ratings statewide. This allows a better understanding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

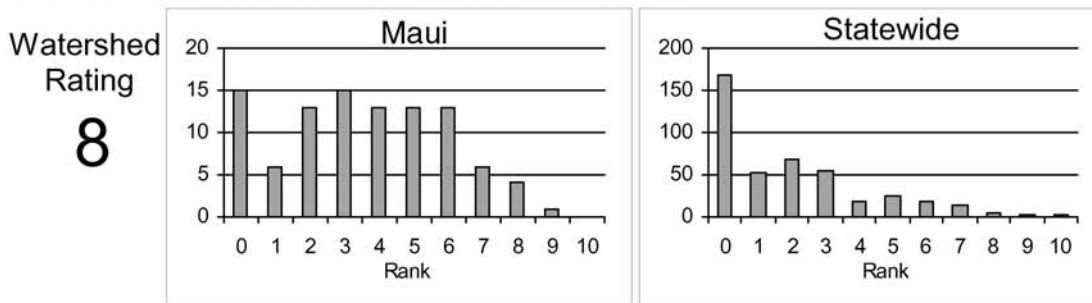
Land Cover Rating: Rating is based on a scoring system where in general forested lands score positively and developed lands score negatively.



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

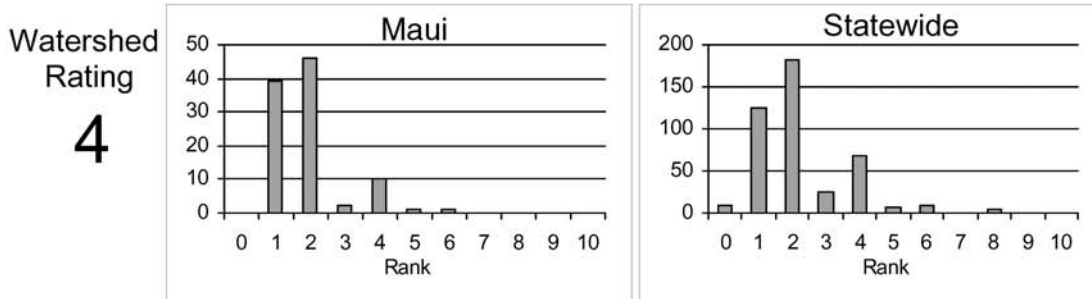


Stewardship Rating: Rating is based on a scoring system where higher levels of land and biodiversity protection within the watershed score positively.

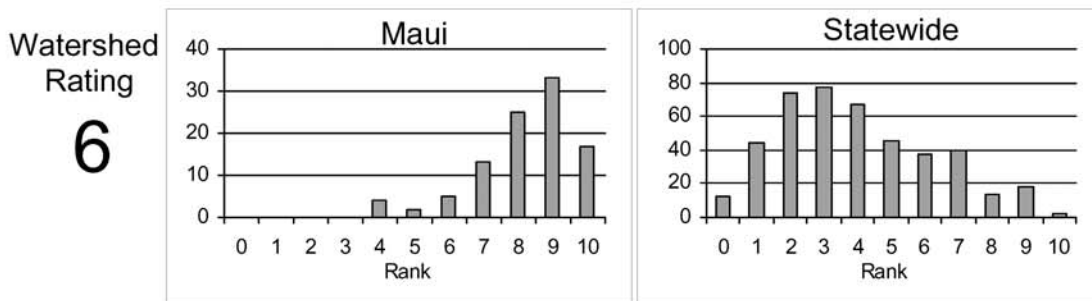


WATERSHED RATING (Cont): Pi'ina'au, Maui

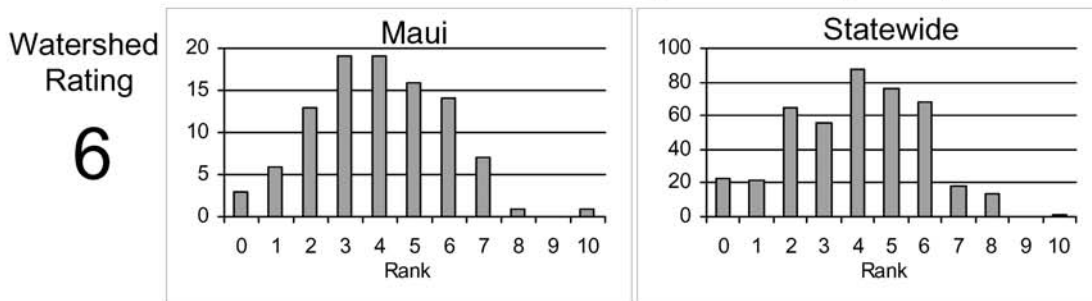
Size Rating: Rating is based on the watershed area and total stream length. Larger watersheds and streams score more positively.



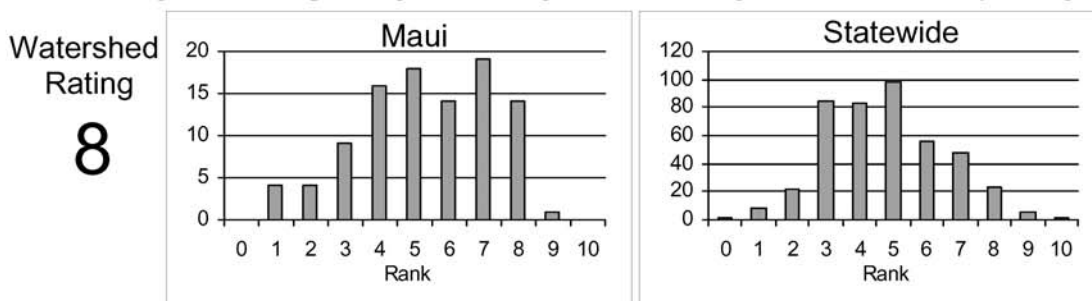
Wetness Rating: Rating is based on the average annual rainfall within the watershed. Higher rainfall totals score more positively.



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



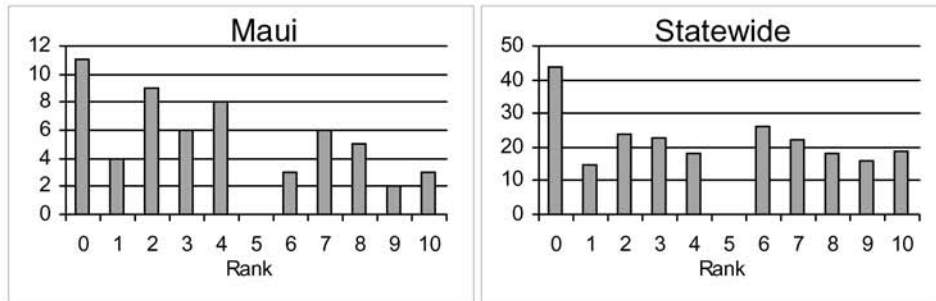
Total Watershed Rating: Rating is based on combination of Land Cover Rating, Shallow Waters Rating, Stewardship Rating, Size Rating, Wetness Rating, and Reach Diversity Rating.



BIOLOGICAL RATING: Pi'ina'au, Maui

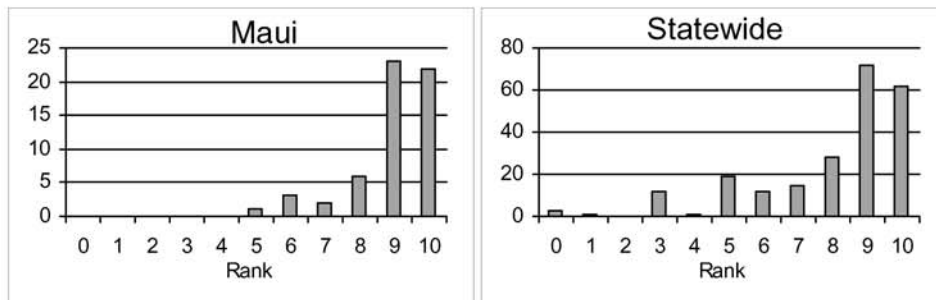
Native Species Rating: Rating is based on the number of native species observed in the watershed.

Stream Rating
10



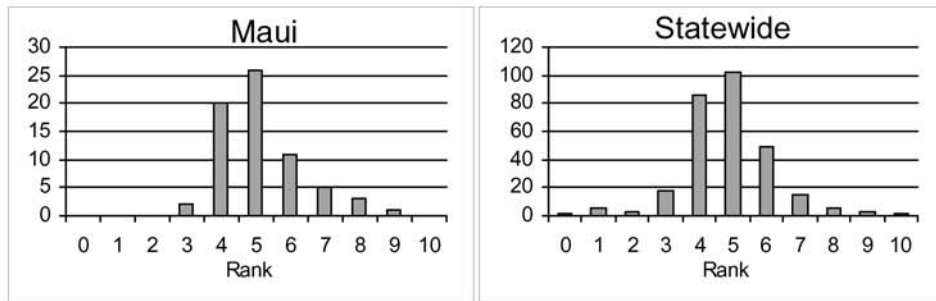
Introduced Genera Rating: Rating is based on the number of introduced genera observed in the watershed.

Stream Rating
7



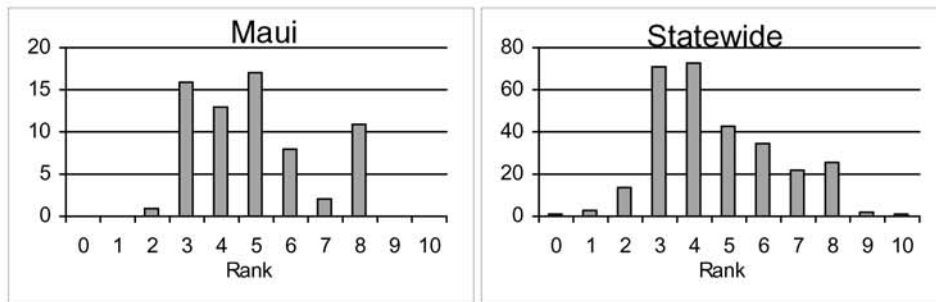
All Species' Score Rating: Rating is based on the Hawaii Stream Assessment scoring system where native species score positively and introduced species score negatively.

Stream Rating
7



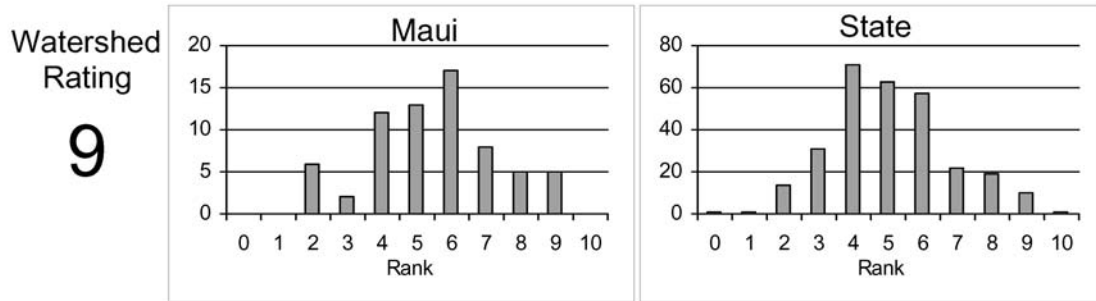
Total Biological Rating: Rating is the combination of the Native Species Rating, Introduced Genera Rating, and the All Species' Score Rating.

Stream Rating
8



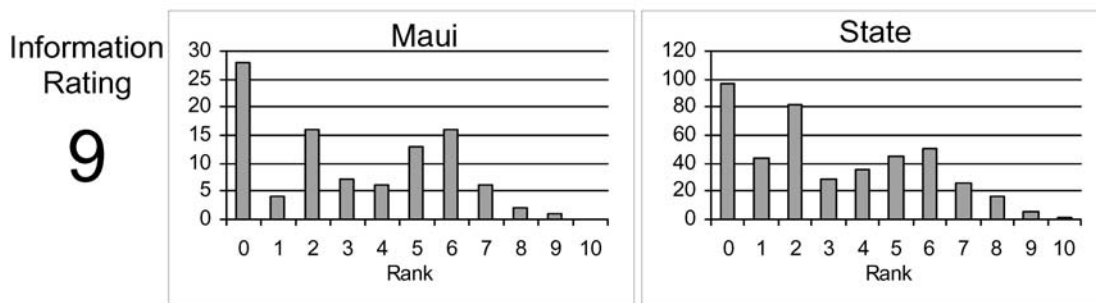
OVERALL RATING: Pi'ina'au, Maui

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



RATING STRENGTH: Pi'ina'au, Maui

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



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

Rana catesbiana

CN: american bull frog; HN: none.

Ranidae sp.

CN: none; HN: none.

Ranidae

CN: unidentified frog; HN: none.

Ranidae

CN: unidentified frog tadpole; HN: none.

Clam

Introduced

Corbicula fluminea

CN: Asiatic freshwater clam; HN: none.

Musculium partumieum

CN: none; HN: none.

Pisidium sp.

CN: none; HN: none.

Crustacean

Endemic

Atyoida bisulcata

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

Macrobrachium grandimanus

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

Indigenous

Amphipoda sp.

CN: amphipod; HN: none.

Introduced

Macrobrachium lar

CN: Tahitian prawn; HN: none.

Fish

Endemic

Eleotris sandwicensis

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

Kuhlia xenura

CN: Hawaiian flagtail (Hoover, 1993, 2003; Randall, 1996a), Mountain bass (DLNR); HN: aholehole.

Lentipes concolor

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

Sicyopterus stimpsoni

CN: `O`opu nōpili; HN: `O`opu nopili.

Appendix 1: Scientific and Common Names (continued)

CN = Common Name and HN = Hawaiian Name

Stenogobius hawaiiensis

CN: `O`opu naniha; HN: `O`opu naniha.

Indigenous***Awaous guamensis***

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

Gobiidae

CN: unidentified goby; HN: none.

Kuhlia sp.

CN: flagtail; HN: none.

Introduced***Poecilia reticulata***

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

Insect**Endemic*****Anax strenuus***

CN: blue dragonfly; HN: Pinao.

Megalagrion blackburni

CN: none; HN: none.

Megalagrion nigrohamatum nigrohamatum

CN: yellow damselfly; HN: none.

Megalagrion pacificum

CN: Pacific Hawaiian damselfly; HN: none.

Megalagrion sp.

CN: damselfly larvae; HN: none.

Indigenous***Anax junius***

CN: none; HN: none.

Anax sp.

CN: none; HN: none.

Telmatogeton sp.

CN: diptera cocoon; HN: none.

Telmatogeton sp.

CN: diptera larvae; HN: none.

Introduced***Chironomid larvae***

CN: none; HN: none.

Snail**Endemic*****Neritina granosa***

CN: none; HN: Hihiwai or wi.

Neritina vespertina

CN: none; HN: Hapawai or Hapakai.

Introduced

Lymnea sp.

CN: none; HN: none.

Physidae

CN: none; HN: none.

Pomacea canaliculata

CN: apple snail; HN: none.

Thiarid sp.

CN: none; HN: none.

Section 3: DAR Point Quadrat Survey Report

DAR Point Quadrat Survey Report for Pi'ina'au Stream, Maui for surveys from 4/30/2002 to 4/4/2008

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:

Pi'ina'au (ID: 64011), Ke'anae, Maui

Table 2. Survey Team Personnel:

- Hau, Skippy
- Higashi, Glenn
- Kuamoo, Darrell
- Lapp, Eko
- Leonard, Jason
- Nishimoto, Robert
- Sakihara, Troy
- Shimoda, Troy
- Shindo, Tim
- Young, Rodney

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

<u>Stream Name</u>	<u>Reaches</u>					<u>Total</u>
	<u>Estuary</u>	<u>Lower</u>	<u>Middle</u>	<u>Upper</u>	<u>Headwater</u>	
Pi'ina'au		6	94	46		146

Lower Reach of Pi'ina'au stream, Maui, Hawai'i

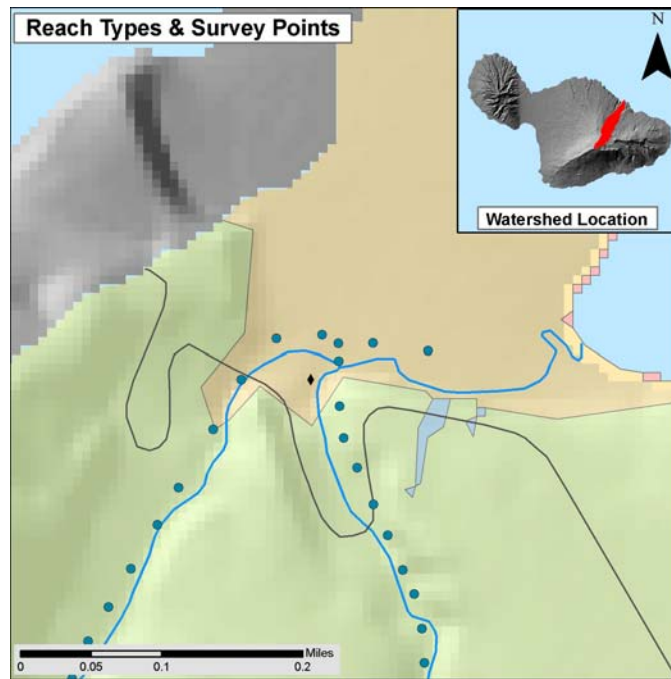


Figure 1. Represents the Point Quadrat Surveys done in the low reach of Pi'ina'au Stream. Blue Dots are the survey locations, the colors are the reach delineations, and the dark gray line is a road.

Lower Reach:

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>
		2	2		1	
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>
0	5	4	1	0	33	57

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg. Density</u>	<u>Total # observed</u>
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Lower	0.73	2
Fish	Indigenous	<i>Awaous guamensis</i>	Lower	1.1	3
Fish	Endemic	<i>Sicyopterus stimpsoni</i>	Lower	0.73	2
Snails	Endemic	<i>Neritina granosa</i>	Lower	3.3	9

Middle Reach of Pi'ina'au stream, Maui, Hawai'i

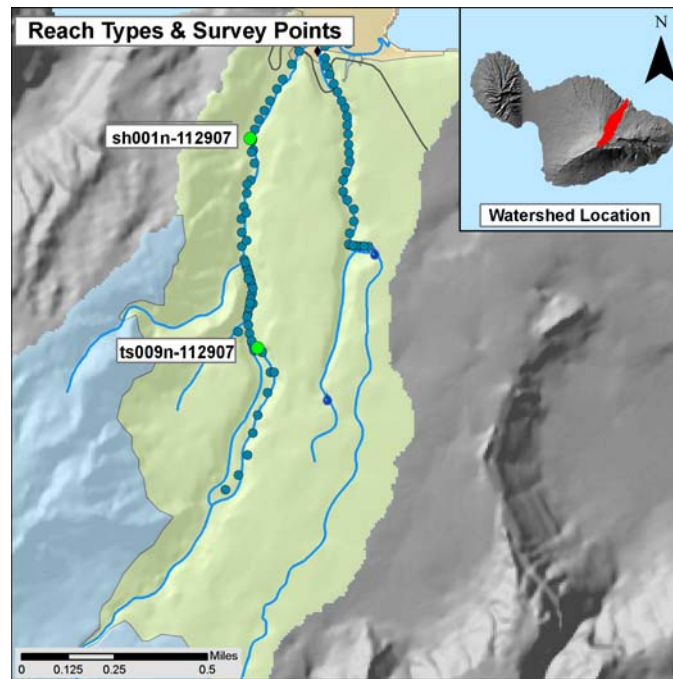


Figure 2. Represents the Point Quadrat Surveys done in the middles reach of Pi'ina'au Stream. Blue Dots are the survey locations, the colors are the reach delineations, and the dark gray line is a road. Green label dot are site with associated photographs

Middle Reach:

							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>							
1	6	30	29	2	11	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>							
4	2	7	9	17	22	40							

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg. Density</u>	<u>Total # observed</u>
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Middle	0.29	11
Fish	Indigenous	<i>Awaous guamensis</i>	Middle	0.55	21
Fish	Endemic	<i>Sicyopterus stimpsoni</i>	Middle	0.16	6
Fish	Endemic	<i>Lentipes concolor</i>	Middle	0.5	19
Snails	Introduced	<i>Physidae</i>	Middle	0.03	1
Snails	Endemic	<i>Neritina granosa</i>	Middle	2.02	77

Upper Reach of Pi'ina'au stream, Maui, Hawai'i

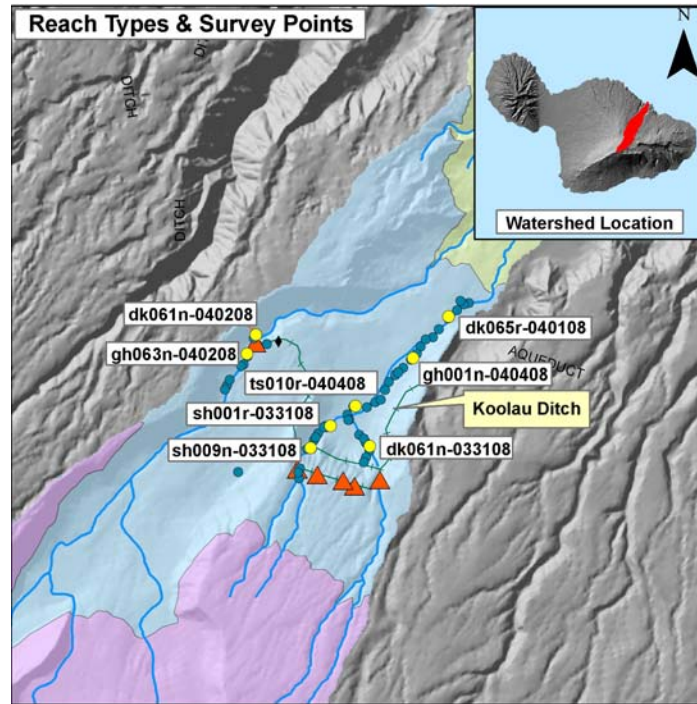


Figure 3. Represents the Point Quadrat Surveys done in the upper reach of Pi'ina'au Stream. Blue Dots are the survey locations, the colors are the reach delineations, and the dark gray line is a road. Yellow label dot are site with associated photographs and the orange triangles are the location of stream diversions.

Upper Reach:

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	10	10	5	2	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>
6	1	2	10	12	34	35

<u>Category</u>	<u>Status</u>	<u>Scientific Name</u>	<u>Reach</u>	<u>Avg Density</u>	<u>Total # observed</u>
Amphibians	Introduced	<i>Ranidae</i>	Upper	0.08	2
Crustaceans	Introduced	<i>Macrobrachium lar</i>	Upper	0.04	1
Crustaceans	Endemic	<i>Atyoida bisulcata</i>	Upper	1.26	32
Fish	Endemic	<i>Sicyopterus stimpsoni</i>	Upper	0.04	1
Snails	Introduced	<i>Physidae</i>	Upper	0.12	3

Section 4: DAR Aquatic Insect Report
Headwaters:

Only insect surveys were done in the headwaters of this stream.

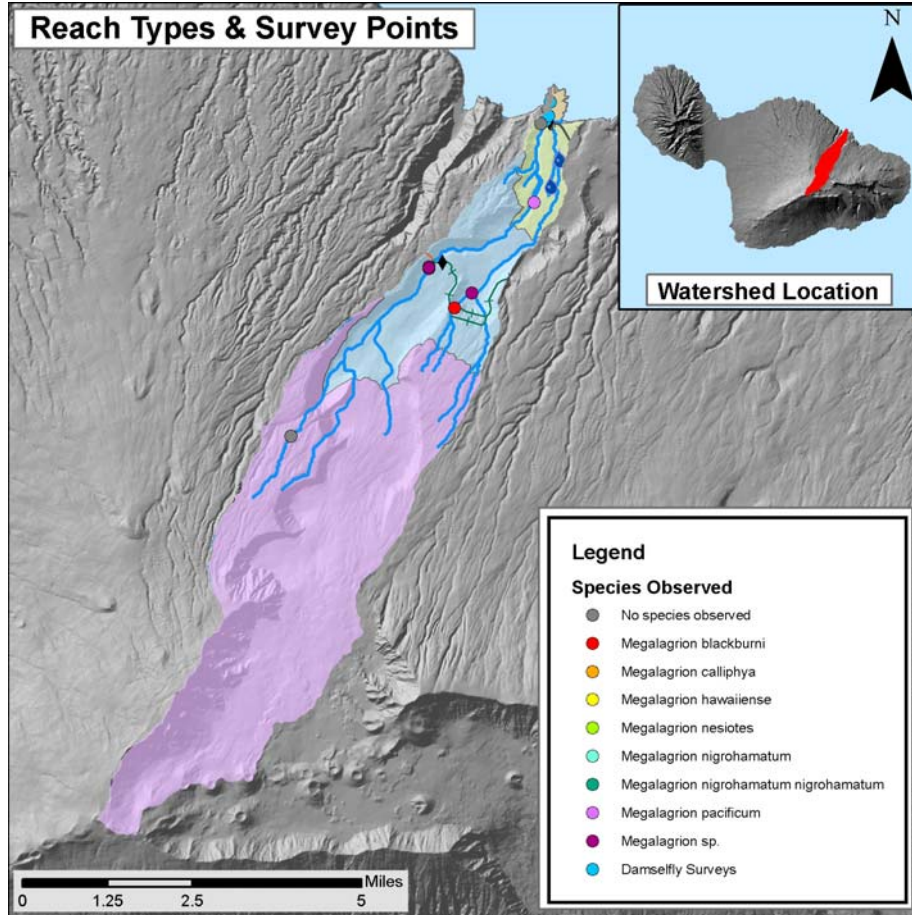


Figure 4. Location of Megalagrion species observed in Pi'ina'au Stream, Maui, Hawai'i.

Table 7. Megalagrion species observed in each stream reach.

Pi'ina'au			Reach
Insect	Endemic	<i>Megalagrion blackburni</i>	Upper
Insect	Endemic	<i>Megalagrion nigrohamatum nigrohamatum</i>	Upper
Insect	Endemic	<i>Megalagrion pacificum</i>	Middle
Insect	Endemic	<i>Megalagrion sp.</i>	Upper

**RECORDS OF AQUATIC INSECTS FROM
PI'INA'AU STREAM, EAST MAUI WATERSHED**

Table 1: Aquatic insect taxa sampled from Pi'ina'au Stream, Station 1, at Hana Road crossing, 40 ft., 31 January 2000
20°51'27.3"N, 156°08'56.6"W

Insect Taxon	Taxon Type
--------------	------------

No captures

Table 2: Aquatic insect taxa sampled from Pi'ina'au Stream, Station 2, taro field at Keanae Arboretum, 8 July 1993

Insect Taxon	Taxon Type
--------------	------------

ODONATA

Coenagrionidae

Megalagrion pacificum (McLachlan)

Native

Table 3: Aquatic insect taxa sampled from Palauhulu Stream, Station 10, 3 March 1998
20.81826°N, 156.16954°W

Insect Taxon	Taxon Type
--------------	------------

ODONATA

Coenagrionidae

Megalagrion blackburni (McLachlan)

Native

Table 4: Aquatic insect taxa sampled from Pi'ina'au Stream, 4 April 1998
20.82139°N, 156.16553W

Insect Taxon	Taxon Type
--------------	------------

ODONATA

Coenagrionidae

Megalagrion nigrohamatum nigrohamatum (Perkins)

Native

Table 5: Aquatic insect taxa sampled from Pi'ina'au Stream, Station 3, west side of Koolau Gap, Koolau Forest Reserve, 4400 ft. (1340 m.), 13 May 1998
20°46.82'N, 156°12.19'W

Insect Taxon

Taxon Type

No captures

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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 Pi'ina'au Stream, Maui to the depths where animals were observed. Additionally, we also compared the observations for Pi'ina'au Stream to depth observations for all streams statewide surveyed using Point Quadrat Surveys to see if the pattern for Pi'ina'au 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 Pi'ina'au Stream, Maui (Watershed code = 64011) 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 Pi'ina'au Stream and for all sites statewide in the DAR Point Quadrat Surveys. Additionally, the difference between the percent frequencies for each depth bin with 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:

The depth use by the native animals observed in Pi'ina'au Stream suggests that a water depth of approximately 20 inches deep was highly suitable for most species (Figure 1). The trend of low suitability at shallower depths and high suitability at deeper depths was similar for all species even with low sample size for some of the species.

The pattern of the distribution of observed depths in Pi'ina'au Stream in comparison to the statewide average depths reveals that dry sites are much more common in Pi'ina'au than in most Hawaiian Streams (Figure 2). The sample size was 143 sites for Pi'ina'au Stream in comparison to 6084 sites statewide. There were approximately 18% more dry sites than observed in the statewide data set (Figure 3). In contrast to the increase in dry sites, there was a decrease in all other depth bins with the largest loss in the 20 inch depth bin.

When observing the distribution of average depth as a function of elevation, the depths did not stay stable or increase in a downstream direction as expected (Figure 4). Two elevation groups were much shallower than the others. The average depth observed in the elevation ranges from 75 to 100 m and 200 to 400 m were between 3 and 8 inches in depth while the rest of the stream's average depths were between 15 and 20 inches.

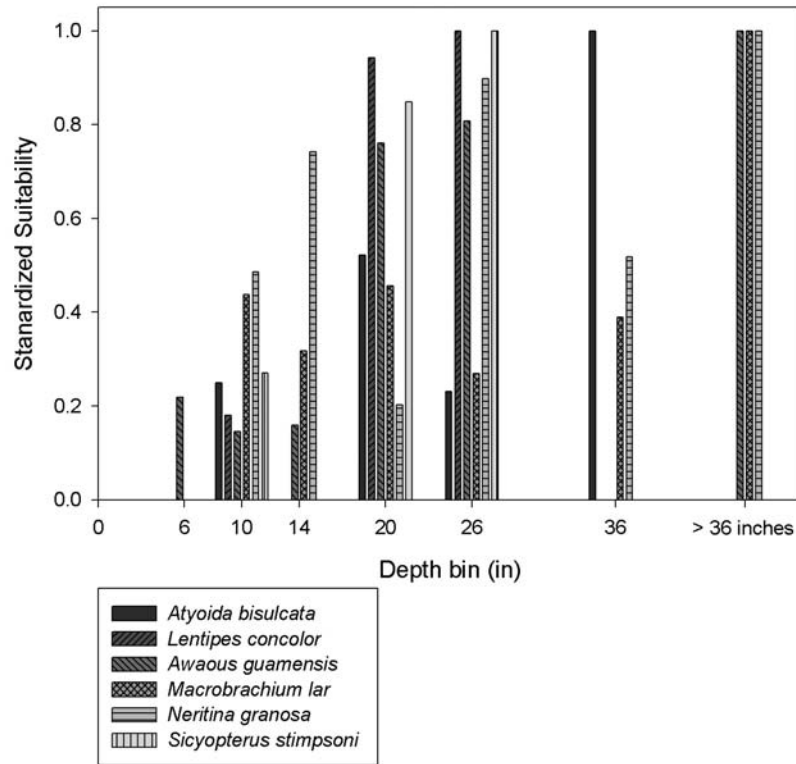


Figure 1. Depth Suitability for animals observed in DAR Point Quadrat Surveys in Pi'ina'au Stream, Maui.

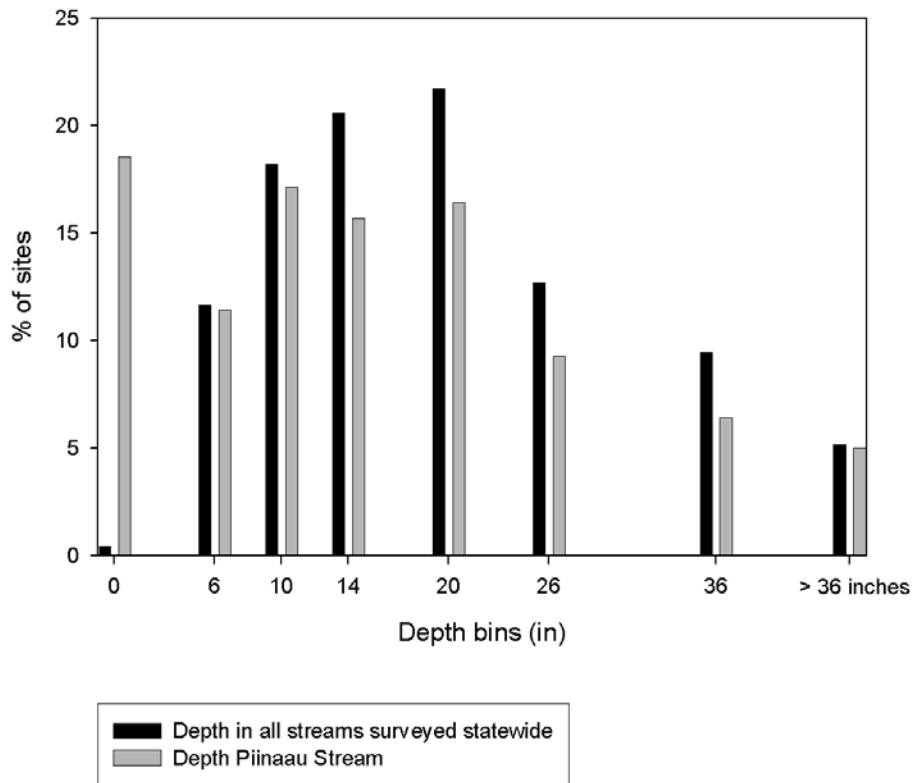


Figure 2. Comparison of percent availability for depth categories between Pi'ina'au Stream, Maui and all streams statewide in the DAR Aquatics Surveys Database.

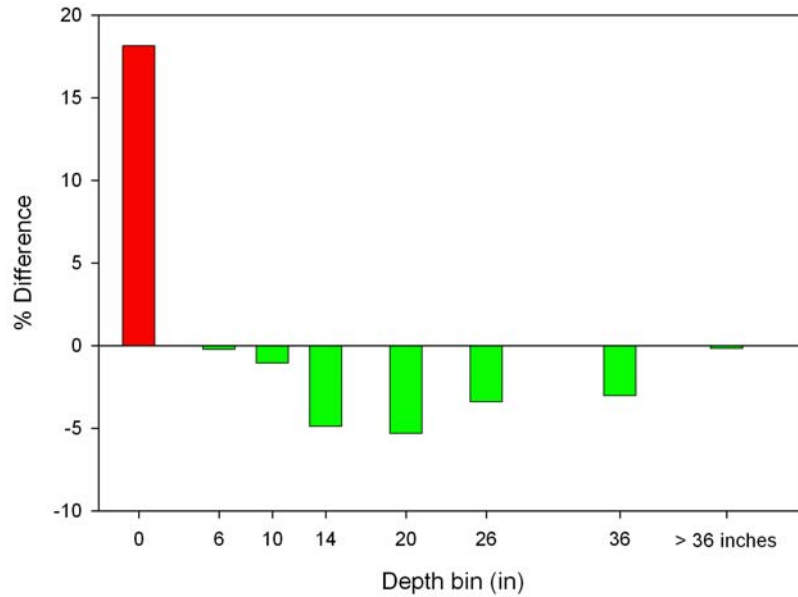


Figure 3. Percent difference in depth categories between Pi'ina'au Stream, Maui and all streams in DAR Aquatics Surveys Database. Positive values (red) denote an increase in the percent frequency of a depth category in Pi'ina'au Stream as compared to streams statewide. Negative values (green) denote a decrease in the percent frequency of a depth category in Pi'ina'au Stream as compared to streams statewide.

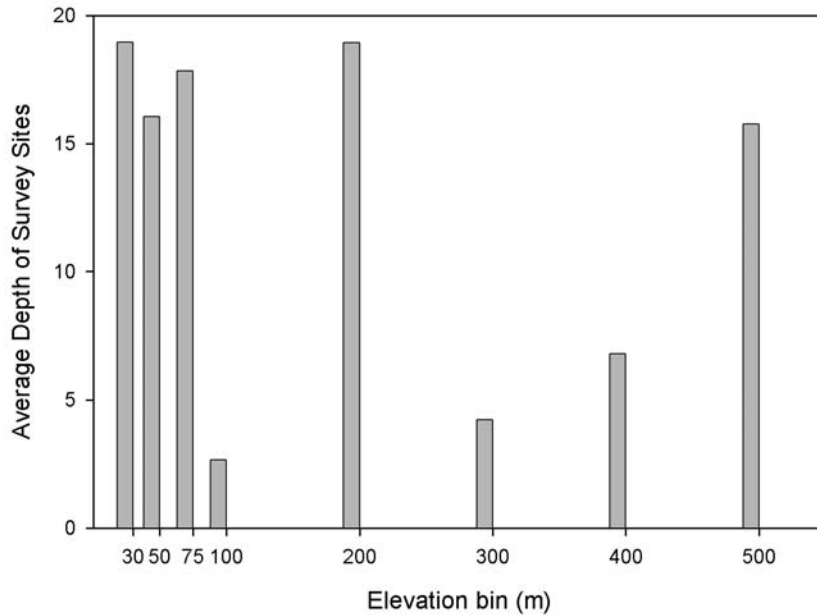


Figure 4. Average depth observed in Point Quadrat Survey Sites for different elevation bins. The elevation bins include all sites up to and including the elevation value. For example, the first bin would include all sites with elevations from 0 to and including 30 m, the second bin would include all sites greater than 30 m to and including 50 m, and so on. Depth is in inches.

Conclusions:

The native animals observed in Pi'ina'au Stream displayed a depth suitability pattern that ranged from highly unsuitable at dry or shallow sites to highly suitable at site approximately 20 inches depth or deeper. This general pattern was followed by all of the native fishes and macroinvertebrates observed and thus deeper waters in a stream are likely more important to native stream animals. The general pattern observed in Pi'ina'au Stream was consistent with depth suitability findings for these species statewide suggesting that the native animals in Pi'ina'au behave in a fairly typical pattern.

While the animals that existed in Pi'ina'au Stream display normal depth selectivity, the availability of suitable depths was quite different in Pi'ina'au Stream than observed in streams statewide. The frequency of sampling a dry site went from about 1 in 200 sites statewide to more than 1 in 6 sites in Pi'ina'au. Field surveyors noted that native animals were restricted to disconnected deep pools in an otherwise dry stream bed in a number of different sections in the stream. In sections where water still flowed, the stream animals were observed in a wider range of habitats.

Field surveyors repeatedly noted that the dry sections of the stream were associated with stream diversions and this is supported by images in the photograph section of this report. When the distribution of average depths was plotted as a function of elevation, a pattern of wet and dry streams sections were also 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 Pi'ina'au Stream would likely have a beneficial effect on the availability of suitable depths for native species in the currently dewatered stream sections. Additionally, given the presence of the full compliment of native animals already present in the stream, the return of water into Pi'ina'au Stream would increase the available habitat for an ecosystem that still contains a natural species assemblage.

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Section 6: Photographs taken during stream surveys

Estuary:



Mouth of Pi'ina'au Stream under normal discharge flow conditions



Mouth of Pi'ina'au Stream under high discharge flow conditions

Lower Reach:



Concrete weir (mentioned in Overview) which “partially” diverts water from Palauhulu Stream for taro patches (lo‘i)..

Middle Reach:

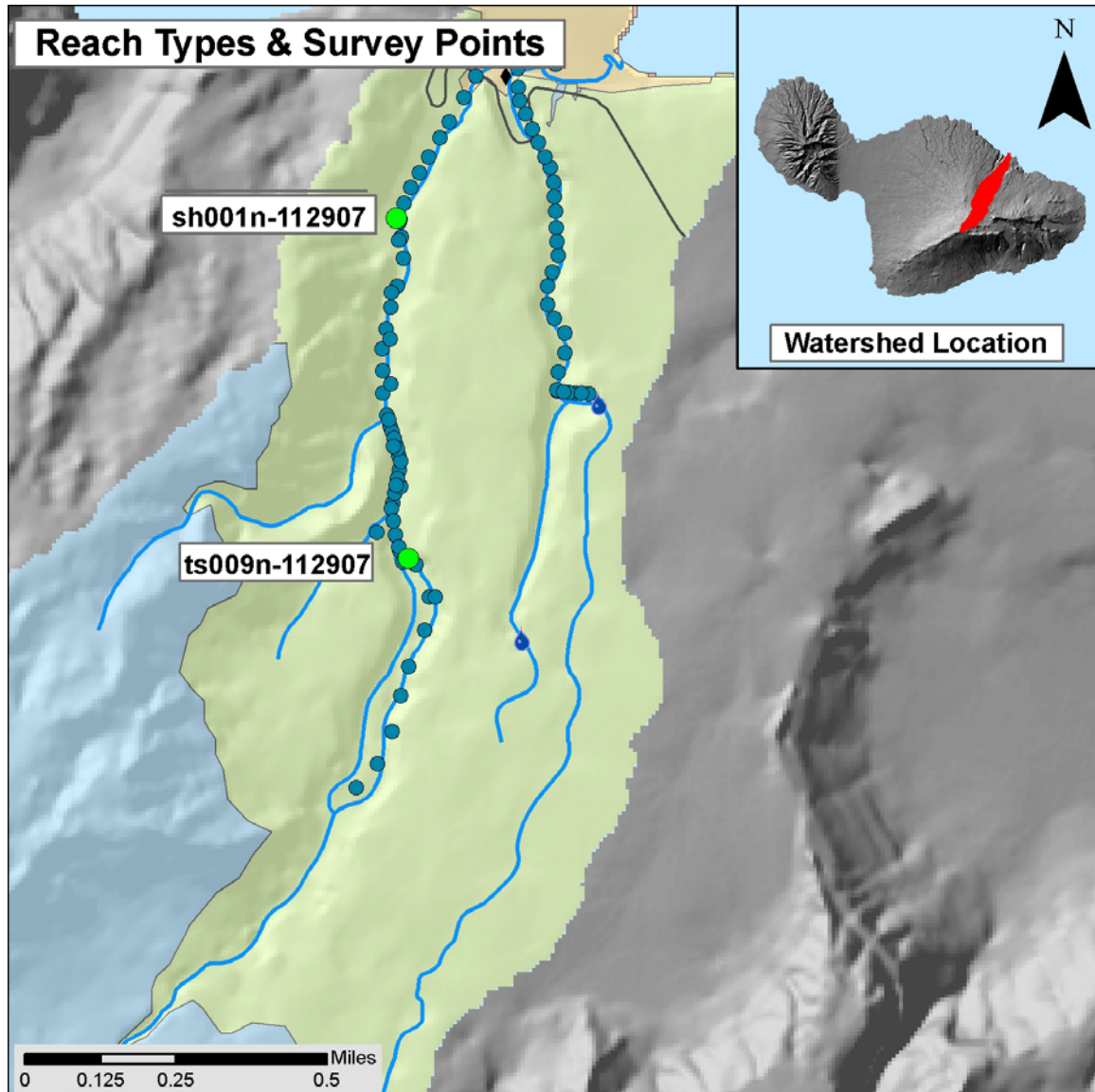


Figure 2. Blue Dots are the survey locations, the colors are the reach delineations, and the dark gray line is a road. Green label dot are site with associated photographs



Image of the middle reach Pi'ina'au. Survey book number sh001n-112907, the first site surveyed on 11/29/2007. Photo taken by Skippy Hau.



Images of the middle reach of Pi'ina'au stream, Maui, Hawai'i. Right is survey book number ts009n-112907, the last survey done on 11/29/2007. Left is an image of the dry stream bed. Taken by Skippy Hau.

Upper Reach:

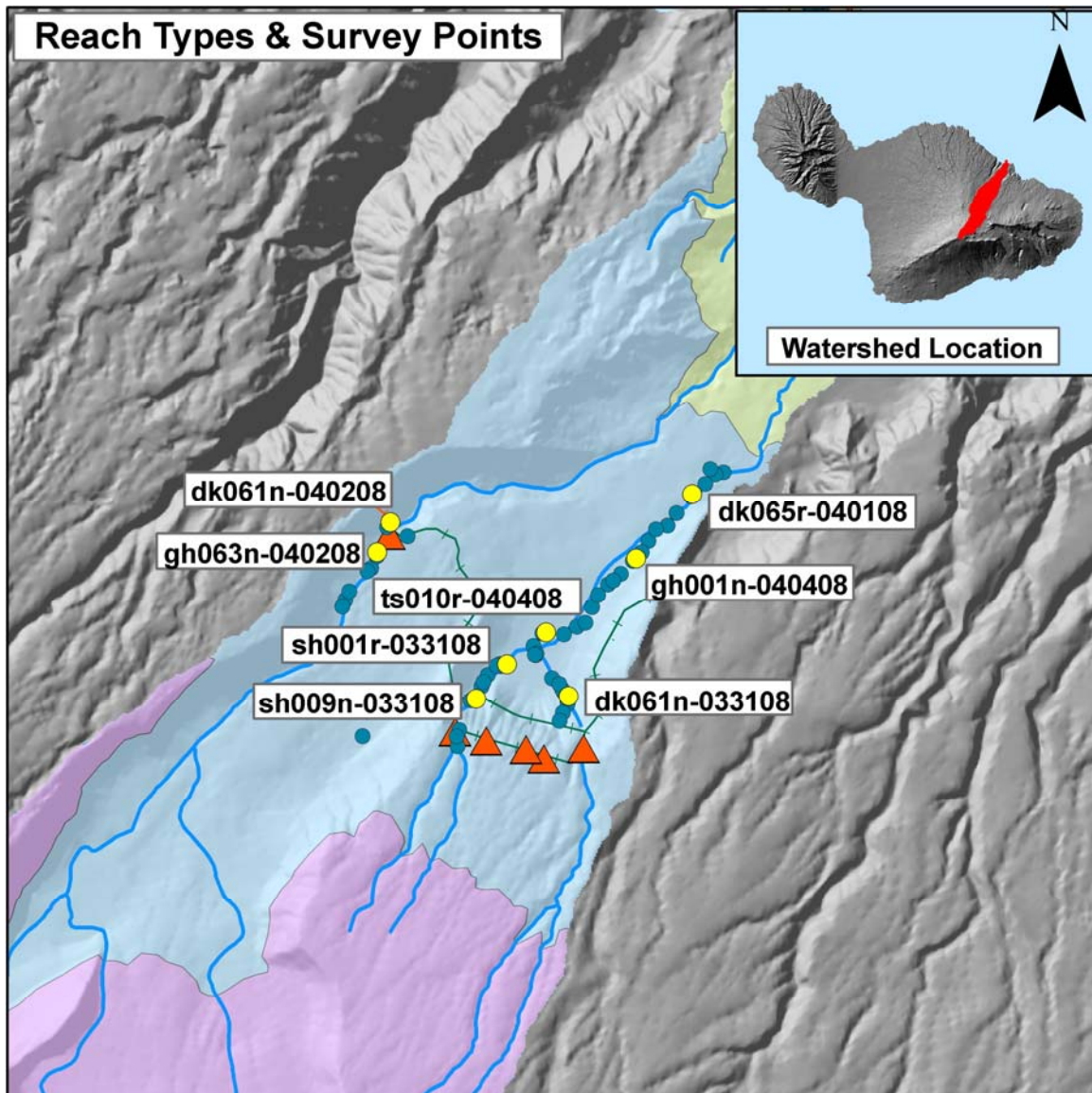


Figure 3. Represents the Point Quadrat Surveys done in the upper reach of Pi'ina'au Stream. Blue Dots are the survey locations, the colors are the reach delineations, and the dark gray line is a road. Yellow label dot are site with associated photographs and the orange triangles are the location of stream diversions.



View downstream of diversion maintenance bridge and diversion structure below at site dk061n-040208. Upper reach Pi'ina'au Stream, Maui, Hawai'i.



View downstream below the diversion bridge from site dk061n-040208. Note that the stream channel below is completely dry as the diversion structure spans the stream channel width. Upper reach Pi'ina'au Stream, Maui, Hawai'i.



View upstream at next diversion from previous site gh063r-040208. Note 6" black PVC pipe (yellow arrow) on the right which is diverting water from the stream channel and carrying it downstream. Upper reach Pi'ina'au Stream, Maui, Hawai'i.



View downstream of diversion pool site gh063r-040208. Black 6" PVC pipe (yellow arrow) in the middle is carrying water downstream. Upper reach Pi'ina'au Stream, Maui, Hawai'i.



Note water pouring from white 6" PVC in middle of the photo (yellow oval). This is connected to the black PVC from the 2nd diversion in the previous photos. Distance between 1st diversion and 2nd is about 300 feet and that part of the stream channel was dewatered at the time of the survey. Unidentified gobies were observed in a pool below the 2nd diversion.

Upper Reach of Palauhulu Stream, a tributary of Pi'ina'au Stream, Maui

The upper reach is characterized by narrow stream channel that is cut through bedrock with steep banks. It consists of small plunge pools and runs separated by small waterfalls.



Left - View upstream from this site (SBN dk065r-040108). Note old concrete weir in lower portion of photo and just above remnants of concrete gauge on the right.

Right - Site SBN gh001n-040408_1 view upstream on Pi'ina'au. Site is below bridge crossing, note the bottom of concrete bridge structure spanning stream channel on top



View downstream from gh001n-040408_1 site.



The stream channel opened up and contained typical boulder/cobble substrate further upstream below this site (SBN ts010r-040408).



Picture on the right and the left is survey site dk061n-033108. Both sites are located in the upper reach of Pi'ina'au Stream, Maui, Hawai'i.



Headwaters trickling into standing pool (sh009n-033108_1)



Standing pool with Tahitian prawns & native mountain opae (sh009n-033108_2)

Headwaters:

Only insect surveys were done in the headwaters of this stream. No photographs of sites were taken.



Native damselfly, *Megalagrion pacificum*, currently a candidate for listing as an endangered species

Civil No. 19-1-0019-01 (JPC)

Defendant A&B/EMI's Exhibit AB-146

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