

CHAPTER 4: MIP *ACHATINELLA MUSTELINA* MANAGEMENT

The MIP stabilization plan for *Achatinella mustelina* outlines protection measures for each of six Evolutionarily Significant Units (ESU) in the Waianae Mountains. Each ESU is considered a genetically distinct group and thus important to conserve in stabilizing the taxon. In order to reach stability for *A. mustelina*, OANRP must work towards attaining the goals below.

4.1 *ACHATINELLA MUSTELINA* STABILIZATION PLAN SUMMARY

4.1.1 Long Term Goals

- Manage snail populations at eight field locations to encompass the extant range of the species and all six genetically defined ESUs. ESU-B and ESU-D each have two populations of special interest because of their extensive geographic area.
- Maintain at least 300 snails per population.
- Maintain captive populations for each of the six recognized ESUs.

Control all threats at each managed field location.

This update will cover the following sections: captive propagation, genetic issues, monitoring, reintroduction, threats, threat control development, research and ESU status updates. Each ESU status update contains highlights from the reporting year and plans for the upcoming year.

4.1.2 Captive Propagation

The MIP captive propagation goal is stated above. The following questions were posed in the 2009 report and at the 2010 snail IT meeting, a subcommittee was formed to address them. The subcommittee has not yet met but it is OANRP's goal to convene this group this fall to present at the 2011 Snail IT meeting. The questions posed in considering how to meet this goal were:

1. What is the minimum number of snails required and of what size classes to consider an ESU adequately represented? The MIP says 50 snails per ESU but does not specify size classes required.
2. What is the recollection interval and what triggers recollection: low numbers, slow reproduction, age structure consideration?
3. What is the purpose of the captive population? Many of these ESUs span large geographic areas and the MIP 300 snails target can be met by managing only a portion of this range. Is the captive population just for restoration of managed sites if they are extirpated or severely reduced in numbers? Or is it to represent the ESU across its range?
4. What reduction in the wild population would trigger using a captive population in this manner?

Captive populations of *Achatinella mustelina* have not performed well and are currently at very low numbers. Per the recommendation of the Tree Snail Lab, OANRP will not collect any new *A. mustelina* for long-term captive rearing until these issues are resolved. Reasons for this decline are unclear but active investigation in order to resolve any propagation technique issues are underway. OANRP fully support making changes to the laboratory conditions to best suit each tree snail taxon and maximize population growth and success in the lab. Over the last year, the UH tree snail lab has attempted to cultivate fungal stock from wild sources to diversify the food supplied to lab snails. In addition, the laboratory is experimenting with varying day length within the growth chambers to determine the effect on population growth. Results from both these studies are still pending. Also, the Army purchased one new state of the art incubator for the lab. The 2010 Captive Snail Propagation Summary table for *A. mustelina* is included below.

Captive Snail Propagation Summary for *Achatinella mustelina*

Population	ESU	Date	# juv	# sub	# adult	# Individuals
Peacock Flats	A	1995	0	0	6	6
		2003	–	–	–	21
		Apr-04	8	11	4	23
		Sep-05	3	15	2	20
		Aug-06	1	12	3	16
		Jul-07	0	9	2	11
		Aug-08	0	3	3	6
		Aug-09	0	2	0	2
		Aug-10	0	0	2	2
Ōhikilolo – Makai	B1	2003	0	0	10	10
		Apr-04	27	0	4	31
		Sep-05	15	8	0	23
		Aug-06	3	9	0	12
		Jul-07	1	9	1	11
		Aug-08	0	9	0	9
		Aug-09	0	8	0	8
		Aug-10	0	6	1	7
Ōhikilolo – Mauka	B1	2003	0	0	8	8
		Apr-04	20	5	0	25
		Sep-05	18	7	0	25
		Aug-06	0	21	2	23
		Jul-07	0	12	1	13
		Aug-08	0	11	1	12
		Aug-09	0	10	0	10
		Aug-10	0	4	0	4
Ka'ala S rdge	B2	2003	0	0	10	10
		Apr-04	23	0	6	29
		Sep-05	19	5	0	24
		Aug-06	4	11	0	15
		Jul-07	0	4	1	5
		Aug-08	0	3	1	4
		Aug-09	0	2	1	3
		Aug-10	0	1	0	1
Alaihehe Gulch	C	2003	0	0	10	10
		Apr-04	14	4	4	22
		Sep-05	17	5	0	22
		Aug-06	2	20	0	22
		Jul-07	2	21	0	23
		Aug-08	1	20	0	21
		Aug-09	0	17	0	17
		Aug-10	0	0	11	11
Palikea Gulch	C	2003	0	0	10	10
		Apr-04	20	1	8	29
		Sep-05	22	3	2	27
		Aug-06	12	13	0	25
		Jul-07	0	22	2	24
		Aug-08	0	20	1	21
		Aug-09	0	17	1	18
		Aug-10	0	8	1	8
Schofield Barracks West Range	C	2003	0	0	10	10
		Apr-04	15	1	9	25
		Sep-05	27	1	2	30
		Aug-06	8	22	0	30
		Jul-07	2	28	0	30
		Aug-08	0	26	1	27
		Aug-09	0	23	1	24
		Aug-10	0	17	2	19

Population	ESU	Date	# juv	# sub	# adult	# Individuals
10,000 snails	D1	2001	0	0	9	9
		2003	–	–	–	29
		Apr-04	8	22	0	30
		Sep-05	3	24	3	30
		Aug-06	1	24	3	28
		Jul-07	7	14	4	25
		Aug-08	8	13	0	21
		Aug-09	9	2	0	11
		Aug-10	0	8	2	10
Schofield South Range	D1	2003	0	0	10	10
		Apr-04	18	7	3	28
		Sep-05	24	2	0	26
		Aug-06	11	12	0	23
		Jul-07	0	21	0	21
		Aug-08	0	15	3	18
		Aug-09	0	11	2	13
		Aug-10	0	7	4	11
Mākaha	D2	2003	0	0	10	10
		Apr-04	16	0	8	24
		Sep-05	23	0	3	26
		Aug-06	10	14	0	24
		Jul-07	5	17	0	22
		Aug-08	0	20	0	20
		Aug-09	0	10	0	10
		Aug-10	0	2	6	8
Ē kahanui - Hono'uli'uli	E	2003	0	0	10	10
		Apr-04	24	2	3	29
		Sep-05	22	2	0	24
		Aug-06	7	9	0	16
		Jul-07	2	9	1	12
		Aug-08	0	8	0	8
		Aug-09	0	6	0	6
		Aug-10	0	0	5	5
Palikea Lunch / former Pālehua	F	1997	1	0	0	1
		Apr-04	4	0	4	8
		Sep-05	20	0	2	22
		Aug-06	5	14	0	19
		Jul-07	1	15	0	16
		Aug-08	0	13	0	13
		Aug-09	0	3	0	3
		Aug-10	0	3	0	3
TOTAL		2003	–	–	–	138
TOTAL		Apr-04	–	–	–	303
TOTAL		Sep-05	–	–	–	299
TOTAL		Aug-06	–	–	–	255
TOTAL		Jul-07	–	–	–	213
TOTAL		Aug-08	–	–	–	180
TOTAL		Aug-09	–	–	–	127
TOTAL		Aug-10	–	–	–	89

Juvenil= $<10\text{mm}$, Sub adult= $\geq 10\text{mm}$ no thickened lip, Adult= $\geq 10\text{mm}$ thickened lip

4.1.3 Genetic Issues

OANRP continues to assist in making collections for genetic investigations. The results of these additional collections will be discussed in the ESU sections. This year staff worked in conjunction with David Sischo in the UH genetics lab to determine the active status and availability of previous samples taken so as to minimize the total number of collections needed. Some samples taken as long as ten years ago are still usable while others have been used up and are no longer available for use.

4.1.4 Monitoring

OANRP propose the monitoring schedule included in the table below for each *A. mustelina* population reference site within each of the 8 managed populations. The Capture Mark Recapture method is abbreviated as CMR. OANRP will utilize the CMR method with a paint pen every three years to obtain trends in population numbers; this schedule will minimize snail handling and field site impacts. The ESU-A study site will be monitored annually in order to inform rat control management efforts already underway. Monitoring methods proposed for other sites were chosen based on habitat impact and population density considerations. The most important change that will be made to snail counts and surveys is methods standardization. Methods standardization includes: defined area of survey; time of year, use of binoculars; and whether or not survey is conducted during the day or at night.

The following are definitions for some of the content in the proposed monitoring table:

Monitoring Method – three options for population trend monitoring include Capture Mark Recapture (CMR), population count and population count-sweep. CMR involves the marking of snail shells one day and later recapturing snails to determine the proportion unmarked to marked in order to estimate true population size. Population count involves conducting a comprehensive survey of snails in a repeatable manner generally at a discrete and small (<30m x 30m) site. Population count-sweep is the same definition except applied across a larger landscape and involving a large group of surveyors moving across a site in a phalanx. Also included in this column is ‘ground shell plot’ used to track shell litter and predation.

Purpose – Any management related purpose for monitoring is listed in this column. If the column is left blank, assume that the main purpose is for reporting to the IT and USFWS.

Method specifics – For all sites, the number of observers and area surveyed will be standardized. Binoculars should always be used by observers when conducting population monitoring during both the day and night. If night surveys are used at a site, then they must be consistently used; day and night counts cannot be compared.

Proposed monitoring plan for *A. mustelina*

ESU	Pop Ref Site Code (s)	Monitoring Method	Frequency	Purpose	Method specifics	Notes
A	MMR-A - Snail Enclosure	CMR entire site	annually	guide rat control	paint pen, entire site, 2 days	continuing at K. Hall research plots
A	MMR-C (Hall Study Site)	CMR entire site	annually	guide rat control	paint pen, entire site, 2 days	continuing at K. Hall research plots
A	MMR-C (greater Maile Flats)	population count-sweep	every 3 years		3 days	

ESU	Pop Ref Site Code (s)	Monitoring Method	Frequency	Purpose	Method specifics	Notes
A	PAH-A State Snail Enclosure	population count	Quarterly/ OANRP monitor every 3 years			Hadfield Lab doing quarterly counts across entire snail enclosure for 30 minutes
A	Maile Flats MMR-C	Ground Shell Plots	annually	guide rat control		annually because rat grid is on-going
B1	MMR-E, F Ohikilolo	population count-sweep	every 3 years			
B1	MMR-H - Koiahi Gulch	population count	every 3 years			
B1	Ohikilolo	Ground Shell Plots	annually	guide rat control		
B2	LEH-C - Culvert 69	population count-sweep	every 3 years		night where you can walk	rappel survey to cliff spots
B2	LEH-D - Culvert 73	population count-sweep	every 3 years			
B2	LEH-J - Lower Down Culvert 69	population count	every 3 years			Habitat easily impacted by monitoring visits
B2	LEH-C, D	Ground Shell Plots	annually	monitor to say whether to start rat control		annually instead of quarterly because habitat easily impacted by monitoring visits
C	SBW-A, B, C - Haleauau	population count	every 6 months	guide additional collections	night survey combo with <i>E. rosea</i> seek and destroy	translocation monitoring
C	SBW-A - Haleauau	Ground Shell Plots	annually	guide rat control		
D1	KAL-A - Land of 10,000 Snails, SBS-B - Puu Hapapa	population count-sweep	annually		night and day	quarterly searches for <i>E. rosea</i>
D1	KAL-A - Land of 10,000 Snails, SBS-B - Puu Hapapa	Ground Shell Plots	annually	guide rat control		
D2	MAK-A - Makaha	population count-sweep	every 3 years		night and day	
D2	Makaha Misc MAK-A and MAK-B	Ground Shell Plots	annually	guide rat control		

ESU	Pop Ref Site Code (s)	Monitoring Method	Frequency	Purpose	Method specifics	Notes
E	EKA-A through EKA-F - Ekahanui	population count-sweep	every 3 years	guide rat control	sweep all sites	night survey where accessible and where previously surveyed at night
E	EKA-A - Ekahanui	Ground Shell Plots	annually	guide rat control		
F	PAK-A through PAK-L - Palikea, and MAU-A - Mauna Kapu	population count	every 3 years		sweep all sites	
F	PAK- M - Palikea	CMR-entire site	annually	guide rat control	paint pen, entire Hall study site, 2 days	continuing at K. Hall research plots
F	PAK-A thru PAK-M Palikea	Ground Shell Plots	annually	guide rat control		

4.1.5 Reintroduction

OANRP drafted rare snail reintroduction protocols in collaboration with the State of Hawaii, the Navy, UH Snail experts and the U.S. Fish and Wildlife Service (USFWS). In 2007, a final draft of these Rare Snail Reintroduction Guidelines was provided to the USFWS for approval as official guidelines. These guidelines have yet to be officially adopted by USFWS. OANRP is still lacking an official protocol for conducting this activity. The first planned reintroduction for *A. mustelina* will be at the KAL-A site within ESU D1. Snails were removed to captivity for a short time because of severe *E. rosea* predation. After a *Euglandina* enclosure is constructed and predator free, the snails will be reintroduced (See ESU D1 for more details). In addition, OANRP plans to construct an enclosure on the Koolau Summit where lab reared *Achatinella lila* can be reintroduced (See Chapter 5 OIP Snail for details).

4.1.6 Threats

Jackson's Chameleons

Seven Jackson's chameleons were collected from the Puu Kumakalii area of Schofield Barracks (ESU-D2), above 2500 ft within the known range of *Achatinella*. These are the first observations of Jackson's chameleons in the Waianae Mountains at these elevations. Gut contents included snails in four endemic genera from two families, including four individuals of *Achatinella mustelina* and native insects in five genera. Details of these findings are included in Appendix 4-1, Holland et al. 2009. In response to this new observed threat, OANRP plan to conduct outreach to educate the general public and soldiers about the impacts of pet releases to the wild (See Chapter 1, Public Outreach Update). In addition, OANRP are funding a University of Hawaii Graduate Assistant (GA) working with Principle Investigator Dr. Brendan Holland (UH tree snail lab) to investigate range size, habitat utilization, reproductive seasonality and feeding strategies in various habitats of Jackson's chameleons. OANRP staff will likely accompany the GA in the field.

Meanwhile, OANRP will continue to survey for and document any chameleons discovered within native habitat.

4.1.7 Threat Control Development

Using Detector Dogs to find *Euglandina rosea*

OANRP funded the Working Dogs for Conservation (WDFC) again this winter to determine the applicability of detector dogs as a *Euglandina rosea* search tool. When they left in 2009, detector dogs had approximately 250 successful encounters with *E. rosea*. Dogs had to be very near to the snail and often had to pass over it more than once to find it. Often *E. rosea* is buried under leaf litter and rocky substrate complicating detection. Because the scent difficulty is similar to crime scene detection work which requires over 400 successful encounters, the 2009 trial was deemed incomplete and inconclusive. The intent of the return visit was to supplement the number of successful encounters to exceed 400. In addition, at the end of the 2010 visit, a formal trial was conducted comparing detection dogs to human teams and both had similar success rates. Dogs seemed to excel in finding small, immature, *E. rosea* which may have application in clearing predator exclosures. The WDFC trial results are included as Appendix 4-2.

Although this trial was not as successful as OANRP had hoped, along the way Staff made contact with a local dog trainer who has agreed to conduct training at no cost to determine if using a dog that is accustomed to the climate and field conditions in Hawaii may have more success targeting *E. rosea*. Work with this local contact is ongoing. OANRP provide *E. rosea* for training and have made two field visits thus far.

Exclosure Designs

E. rosea barrier research continued over this reporting period. OANRP built test boxes for new designs and collaborated with Dr. Holland from the UH Snail Lab. The latest design incorporates three different designs in one final product. It includes two kinds of physical barriers and one electrical barrier. No *E. rosea* escaped from either the rows of wire mesh or electrical barriers. For more details about the designs tested and results see Appendix 4-3. There are plans to build two new snail exclosures in the coming year at Puu Hapapa (KAL-A) and Poamoho Summit (KLO-B).

4.1.8 Research

OANRP contributed to the following six research projects:

1) *Euglandina rosea* prey trail preference tracking studies

The UH Tree Snail Conservation Lab conducted trials in the lab with live *E. rosea* to determine if simple small molecules present in prey slime trails could be used to attract the predators, and to determine if *E. rosea* have a detectable preference in tracking slime trails of different prey species. The long term objective is predator control, assuming a successful means of attracting *E. rosea* is devised. Simple sugars and amino acids were used, as well as slime trails of three different species of prey, in order to begin to understand tracking preferences in *E. rosea*.

Prey slime trail preference trials were conducted using three prey taxa, including the endemic endangered Oahu tree snail *Achatinella lila*, the giant African snail *Achatina fulica*, and the common introduced Asian snail *Bradybaena similaris*. Trials were conducted in the laboratory on branches of ohia, *Metrosideros polymorpha* which is an important host tree for Hawaiian tree snails. Y-shaped ohia branches were used to simulate tree snail habitat and test *E. rosea*'s ability to track and pursue prey via slime trails in trees. The ohia branches also offered trails of two different species simultaneously, as well as one branch with slime trail versus one without. Results of our trials show that *E. rosea* significantly favored branches with slime trails versus water, choosing the branch with slime trail 90% of the time, and that the predatory snails exhibited no significant preference between *B. similaris* and *A. fulica*, or *B. similaris* and *A. lila*. However, *E. rosea* showed a statistically significant preference for *A. lila* over *A. fulica*.

None of the small molecules were found to attract *E. rosea* relative to water controls. The lab team has submitted the results of this study for peer reviewed publication, and if accepted, the study will be included in next year's report.

2) Jackson's Chameleon Biology

The Army is funding a Jackson's chameleon Graduate assistantship (see Section 4.1.6 in this Chapter).

3) Predatory Garlic Snails

Snail surveys have been conducted by staff from the Center for Conservation Research and Training (CCRT) at UH on Kaala for the garlic snail, *Oxychilus alliarius*. These predators are present on Kaala but impacts on native snails, particularly endangered *A. mustelina*, are difficult to quantify. It is very likely that some of these surveys will continue into the next year. The Army is considering funding a project proposal submitted by the CCRT that would assess the potential impacts on *Achatinella* species by studying the distribution of *O. alliarius*. Such a project would provide a basic understanding of *O. alliarius* habitat utilization, current distribution, provide estimates of population densities and perhaps even determine methods for control.

4) Predatory Flatworms

Staff camped in the Koolaus with Dr. Shinji Sugiura, a visiting specialist studying the predatory flatworm, *Platydemus manokwari*. After three days in the northern Koolaus, he concluded that the area is too high in elevation and too cold for survival of this flatworm. During his research time in Hawaii over the last two years, Dr. Sugiura has not observed *P. manokwari* in Hawaii above 2,000 foot elevation. This is good news for native snails because this flatworm is a serious threat to snails that live at lower elevations. He plans to present the results of his two year study at UH in October 2010.

5) Predatory behavior of newly-hatched *Euglandina rosea*

Adult *E. rosea* attack various species of snails and prefer prey smaller than themselves. However, how newly hatched *E. rosea* attack prey has never been reported. The UH Tree Snail Conservation Lab conducted a feeding experiment, demonstrating that newly hatched *E. rosea* juveniles (0.03–0.04 g) attacked and ate prey snails (*Bradybaena similis*, Bradybaenidae) of various sizes (0.02–0.10 g). Although non-gregarious predators generally attack prey much smaller than themselves, *E. rosea* juveniles also attacked prey larger than themselves. Also, juvenile *E. rosea* hatched from the same egg clutch did not cannibalize one another. Furthermore, when *E. rosea* juveniles were experimentally presented with small endemic Hawaiian snails (Tornatellides spp., Achatinellidae, <0.01 g), all attacked the prey and a few consumed the entire prey snail whole, including its shell. Therefore, newly hatched *E. rosea* are effective predators and potentially impact native snail faunas. This manuscript has been accepted for publication in the Journal of Molluscan Studies.

6) Culturing native leaf fungi

The UH Tree snail Conservation Lab currently provides a single species of cultured fungus to all captive snails, as a supplement to fresh native leaves. However, modern mycological studies have shown that dozens of different fungal species can occur on a single leaf surface, and it is currently not well-understood how many, or which species are most important in terms of nutritional health of tree snails. In an effort to obtain additional cultured leaf fungi, and to ultimately improve the health, growth rate and development of captive snails, the UH Tree Snail Lab used *Pisonia* leaves collected from Puu Hapapa and Pahole and cultured 16 different putative species of leaf fungus. Samples of all cultured leaf fungi have been sent to two collaborating labs, one at UH Hilo, and the other at the Southwest Texas Medical Center, for DNA sequence analysis. Once it is confirmed which fungi are native to Hawaii, the lab will culture selected fungi and initiate feeding trials to captive tree snails in the lab.

4.2 ESU UPDATES

The following section contains brief updates for each of the eight OANRP managed sites. Tables contain information about the current status of *A. mustelina* at each ESU. The following is an explanation of information contained in these status tables.

Population Reference Site. The first column lists the population reference code for each field site. This begins with a three-letter abbreviation for the gulch or area name. For example, MMR stands for Makua Military Reservation. Next, a letter code is applied in alphabetic order, according to the order of population discovery. This coding system allows OANRP to track each field site as a unique entity. This code is also linked to the Army Natural Resource geodatabase. In addition, the “common name” for the site is listed as this name is often easier to remember than the population reference code.

Management Designation. In the next column, the management designation is listed for each field site. The tables used in this report only display the sites chosen for Manage for Stability (MFS), where OANRP is actively conducting or planning to conduct management. These sites are generally the most robust sites in terms of snail numbers, habitat quality, and manageability. Other field sites where the OANRP has observed snails are tracked in the database under the designation ‘no management.’ In general, these sites include areas with low numbers of snails and degraded habitat or areas where management would be logistically challenging. The combined population total for sites designated as MFS should be at least 300 snails in order to meet stability requirements.

Population Numbers. The most current and most accurate monitoring data from each field site are used to populate the ‘total snails’ observed column and the numbers reported by ‘size class’ columns.

Threat Control. Shading indicates that the threat is applicable for the field site. ‘Yes’ indicates that a threat is being controlled, ‘Partial’ if some control is in place and ‘No’ if there is no current control underway.

4.2.1 ESU-A Pahole to Kahanahaiki

There are over 300 snails in ESU-A as shown in the status table below, therefore, this ESU meets part of the stabilization goals. Over this reporting period, the Kahanahaiki MU has been maintained as pig-free with a complete rat grid. Snail habitat within the fence is weeded for both canopy and understory weeds.

Achatinella mustelina in ESU-A Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
MMR-A Kahanahaiki Enclosure	Manage for stability	95	2008/11/12	57	14	24	0	Yes	Yes	Yes	Yes
MMR-C Maile Flats	Manage for stability	250	2009/09/16	185	31	34	0	Yes	Yes	Yes	No
PAH-B Pahole Enclosure	Manage for stability	31	2010/08/13	19	6	6	0	Yes	Yes	Yes	Yes
ESU Total :		376		261	51	64	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm


 = Threat to Taxon at Population Reference Site
 No Shading = Absence of threat to Taxon at Population Reference Site
 Yes=Threat is being controlled at PopRefSite
 No=Threat is not being controlled at PopRefSite
 Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on *A. mustelina*.

***Achatinella mustelina* distribution in the Kahanahaiki portion of ESU-A - 2010**

Map removed, available
upon request

Major Highlights/Issues Year 6

- The UH Tree Snail Lab assisted under the direction of OANRP staff with outplanting native canopy trees into the Pahole Snail Exclosure site. A total of 30 trees were dug up in Kahanahaiki where they were growing in dense mats. Species included: *Pisonia sandwicensis*, *Pipturis albidis*, and *Myrsine lessertiana*.
- OANRP obtained results from the short term snail removal to the lab conducted by Kevin Hall on 3/12/09. Ten snails were collected and 16 snails were returned at the end of the 6 month period in captivity. OANRP will document the long term survival of the ten marked adult snails that were returned, during annual CMR efforts.
- No rat predation was observed during this reporting period in ground shell plots. However, two live *E. rosea* were collected in GSPs.
- OANRP completed *Achatinella mustelina* surveys across MMR-C, Maile flats, Kahanahaiki Management Unit. Results of the surveys are presented in the map above.

Plans for Year 7

- Maintain and supplement Pahole exclosure outplantings and perform weed control.
- Work with David Sischo, UH geneticist, to determine if the Peacock Flats lab collection is indeed in ESU-A and compare it to genetic samples taken from wild KAP-C individuals.

4.2.2 ESU-B

ESU-B is a very large ESU. For management purposes it has been split into two portions. ESU-B1 includes snail occurrences on Ohikilolo Ridge and B2 includes occurrences in Central and East Makaleha. Each is discussed separately. Both B1 and B2 have met the IP goal of 300+ total snails.

ESU-B1 Ohikilolo

A survey was initiated here in April 2010 but has not yet been completed thus, for the time being older population status numbers are being used. No *E. rosea* have ever been observed at Ohikilolo and OANRP continue to be vigilant about gear inspection and cleaning.

Achatinella mustelina in ESU-B1 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
MMR-A	Manage for stability	95	2008/11/12	57	14	24	0	Yes	Yes	Yes	Yes
Kahanahaiki Exclosure											
MMR-C	Manage for stability	250	2009/09/16	185	31	34	0	Yes	Yes	Yes	No
Maile Flats											
PAH-B	Manage for stability	31	2010/08/13	19	6	6	0	Yes	Yes	Yes	Yes
Pahole Exclosure											
ESU Total :		376		261	51	64	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

= Threat to Taxon at Population Reference Site
 No Shading = Absence of threat to Taxon at Population Reference Site
 Yes=Threat is being controlled at PopRefSite
 No=Threat is not being controlled at PopRefSite
 Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- Began comprehensive population count proposed for every three years at MMR-H.
- Conducted a survey at MMR-H. Because no signs of rat predation were found, no rat baiting was initiated.
- The rat grid for the Ohikilolo forest patch (MMR-F) was reconfigured and in some areas bait stations were added in order to best cover habitat occupied by *A. mustelina*. Additional rat control was installed near one ground shell plot which showed evidence of recent rat predation.

Plans for Year 7

- Complete population count initiated in April 2010. In the future, conduct this entire count within one quarter.
- Maintain expanded rat grid.

ESU-B2 East and Central Makaleha

ESU-B2 covers a wide geographic area. *A. mustelina* are found on almost every ridge from Central to East Makaleha. Due to management limitations and the geographic spread of these sites, OANRP only

plan to manage the three sites which fall within the proposed East Makaleha MU fence. Current numbers indicate that there are over 300 total snails at ESU B2 (LEH-C). For current *A. mustelina* status in ESU-B2, see the table below. Many of the snails within the two managed sites are located on steep slopes only accessible via rappel and thus these areas are not susceptible to pig impacts. The habitat across ESU-B2 is dissected by narrow ridges which drop off steeply on both sides into deep gulches. This terrain is too steep to construct an *E. rosea* exclosure similar to those existing in ESU-A. In addition, rat control will be difficult. OANRP have concerns about establishing rat baiting trails within this *Dicranopteris linearis* dominated habitat prior to the MU fence for fear that pigs and goats will use these trails.

The goat population is again increasing in this area. Significant goat damage to snail habitat continues to be observed. Goats are moving up into more intact native areas, expanding their range closer to the Kaala Road and more directly into core snail populations. Significant goat reductions are needed in the next year. DOFAW staff have been alerted to this issue and OANRP will continue to assist their staff in control efforts, to the extent allowable under current RCUH firearms use restrictions.

***Achatinella mustelina* in ESU-B2 Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
ESU: B2 East and Central Makaleha											
LEH-C	Manage for stability	430	2010-05-19	267	98	65	0	No	No	No	No
East Branch of East Makaleha (culvert 69)											
LEH-D	Manage for stability	39	2006-05-01	20	16	3	0	No	No	No	No
East Branch of East Makaleha (culvert 73)											
LEH-J	Manage for stability	2	2006-11-16	2	0	0	0	No	No	No	No
East Makaleha (culvert 69 - lower down)											
ESU Total:		471		289	114	68	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	> 18 mm
Medium	8- 18 mm
Small	< 8 mm

= Threat to Taxon at Population Reference Site
 No Shading = Absence of threat to Taxon at Population Reference Site
 Yes=Threat is being controlled at PopRefSite
 No=Threat is not being controlled at PopRefSite
 Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- New surveys were conducted in this ESU over this reporting period for the first time in four years. Ropes were used to access some steep areas for survey. OANRP will conduct a full population count every three years.
- Genetic samples were collected from a population just east of the Dupont Trail in order to determine if it should be placed in ESU B2 or C.
- Met with DOFAW regarding plans for the East Makaleha MU fence construction. This project is pending an MOU or similar agreement between the State of Hawaii and the Army.
- Ground Shell Plots monitoring was reduced from quarterly to annually because of habitat destruction in a steep area at LEH-D and no substantial finds at the other (LEH-C).

Plans for Year 7

- Consider collecting from the East Makaleha portion of this ESU for representation in the UH Tree Snail Lab, pending improvement of lab performance of *A. mustelina*.
- Control incipient canopy weeds within snail habitat in the upper portion of the East Makaleha MU including *Psidium cattelianum* and *Toona ciliata*.
- Meet with DOFAW to plan for construction of the East Makaleha MU fence.
- Continue to monitor ground shell plots annually rather than quarterly to reduce trampling impacts to native habitat.
- Support and encourage DOFAW goat control in East Makaleha.

4.2.3 ESU-C Schofield Barracks West Range (SBW), Alaiheie and Palikea Gulches

The number of snails in ESU-C is extremely low (see the status table below). Access to the SBW sites was improved during this reporting period and thus OANRP have had access to conduct rat control on a monthly basis. Snails have not been seen alive in ALI-A since 2003 and in ALI-B since 2005.

***Achatinella mustelina* in ESU-C Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
ALI-A Palikea gulch	Manage for stability	0	2009/06/02	0	0	0	0	No	No	No	No
ALI-B Palikea gulch west. Just east of Alaiheie/Palikea dividing ridge.	Manage for stability	0	2009/06/02	0	0	0	0	No	No	No	No
ANU-A Manuwai gulch	Manage for stability	1	2004/06/02	0	1	0	0	No	No	No	No
IHE-A Alaiheie Gulch Western Most Site	Manage for stability	0	2005/03/22	0	0	0	0	No	No	No	No
IHE-B Alaiheie middle site "Ptemac Site"	Manage for stability	3	2009/06/02	1	2	0	0	No	No	No	No
IHE-C Alaiheie below Nalu's LZ, TT's spot	Manage for stability	0	2005/03/22	0	0	0	0	No	No	No	No
SBW-A North Haleauau Hame Ridge	Manage for stability	33	2009/05/22	23	7	3	0	Yes	No	Yes	No
SBW-B North Haleauau one ridge north of Hame	Manage for stability	9	2009/09/06	9	0	0	0	Yes	No	Yes	No
SBW-C North Haleauau just above Pouteria pair territory	Manage for stability	0	2009/09/06	0	0	0	0	No	No	No	No
ESU Total :		46		33	10	3	0				
Size Class Definitions				<div style="display: flex; align-items: center;"> <div style="width: 15px; height: 15px; background-color: #cccccc; margin-right: 5px;"></div> Threat to Taxon at Population Reference Site </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="width: 15px; height: 15px; background-color: #ffffff; margin-right: 5px;"></div> Absence of threat to Taxon at Population Reference Site </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="width: 15px; height: 15px; background-color: #cccccc; margin-right: 5px;"></div> Threat is being controlled at PopRefSite </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="width: 15px; height: 15px; background-color: #cccccc; margin-right: 5px;"></div> Threat is not being controlled at PopRefSite </div> <div style="display: flex; align-items: center; margin-top: 5px;"> <div style="width: 15px; height: 15px; background-color: #cccccc; margin-right: 5px;"></div> Threat is being partially controlled at PopRefSite </div>							
SizeClass	Def SizeClass										
Large	>18 mm										
Medium	8-18 mm										
Small	< 8 mm										

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- Rat control grids continue to be maintained year-round within SBW-A and SBW-B where *A. mustelina* are still extant.
- Monitored the seven translocated *A. mustelina* from SBW-C where there is no ungulate fence into a fenced area inside SBW-B. Four of the seven translocated snails were seen on 6 September 2009.
- Located a new population of 14 snails in SBW approximately 400 meters south of the other SBW snail sites. Genetic analysis will determine which ESU they belong to and results will be presented at the IT meeting.
- Still waiting on genetic analysis to determine an ESU designation for snails found along Kamaohanui ridge and approximately 600 meters from SBW-B.

Plans for Year 7

- Secure additional collections to bolster lab population as necessary, pending *A. mustelina* improvement in the lab.
- Maintain rat control.
- Continue to monitor translocated snails at SBW-B.
- Begin construction of 1,800 acre Lihue fence which will pave the way for use of aerial rodenticide and benefit the *A. mustelina* in this ESU.
- Conduct weed control at SBW sites.

4.2.4 ESU-D North Kaluaa, Waieli, Puu Hapapa, SBS, and Makaha

ESU-D is by far the largest ESU geographically. For management purposes it has been split into two portions. D1 includes North Kaluaa, Waieli, Puu Hapapa, and SBS. D2 includes Makaha.

ESU D1 North Kaluaa, Waieli, Puu Hapapa and SBS

This ESU reaches stability goal numbers as the status table below shows. The most substantial remaining challenge is the high number of *E. rosea* observed in the area. A *Euglandina rosea* enclosure is slated for construction during the next reporting period. Large scale common native reintroduction was conducted by TNC and *A. mustelina* are observed utilizing these plantings.

Achatinella mustelina in ESU-D1 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
KAL-A	Manage for stability	236	2009/12/02	107	57	72	0	Yes	Yes	Yes	Partial
Land of 10,000 snails											
SBS-B	Manage for stability	144	2009/07/14	77	34	33	0	No	No	Yes	No
Puu Hapapa											
ESU Total :		380		184	91	105	0				
Size Class Definitions				<div style="display: flex; align-items: center;"> <div style="width: 15px; height: 15px; background-color: #cccccc; margin-right: 5px;"></div> = Threat to Taxon at Population Reference Site No Shading = Absence of threat to Taxon at Population Reference Site Yes=Threat is being controlled at PopRefSite No=Threat is not being controlled at PopRefSite Partial=Threat is being partially controlled at PopRefSite </div>							
<u>SizeClass</u>	<u>DefSizeClass</u>										
Large	>18 mm										
Medium	8-18 mm										
Small	< 8 mm										

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- Conducted current snail census surveys at KAL-A site.
- Determined and cleared the best route for a predator fence for the KAL-A site; see below for details. A total of three camping trips with an average of five personnel per trip were conducted related to this enclosure preparation.
- Performed area sweeps to remove *E. rosea*. Removed a total of 407 *E. rosea* in the past 18 months. Have also eliminated hundreds of *E. rosea* eggs.

- Collected 202 wild snails for the UH Snail Lab for temporary protection from *E. rosea* predation until predator enclosure is constructed. See below for additional details.
- Monitored ground shell plots where no *E. rosea* have been observed. This plot is no longer ideal because of a dramatic drop in *A. mustelina* in the trees above and because the habitat is open and exposed and thus not ideal for *E. rosea*.
- Conducted detection dog trial with WDFC at KAL-A. Dogs were able to detect immature *E. rosea* better than humans. See Appendix 4-2
- Presented at the 2010 Hawaii Conservation Conference about *E. rosea* predation within this ESU. For abstract see the Hawaii Conservation Alliance website.

Plans for Year 7

- Continue rat grid maintenance and ground shell plot monitoring.
- Remove *E. rosea* quarterly.
- Finish snail enclosure preparation and construction.
- Finalize restoration plan for KAL-A associated with *Schinus* removal and enclosure construction.
- Relocate ground shell plot.
- Return snails from the lab.

KAL-A Land of 10,000 snails

After a number of staff noticed a decline in *A. mustelina*, a thorough night survey was conducted on 2 Dec 2009 and a total of 236 snails were counted in 18 person hours. In April 2009, a total of 386 snails were counted in a similar timeframe. The numbers show that while there are still an appreciable number of snails here, their numbers are in steep decline. Over the past 18 months a total of 407 *E. rosea* have been collected here, by far the highest density OANRP staff have ever seen anywhere on Oahu. OANRP have instituted quarterly *E. rosea* sweeps at this site.

The observed decline in snail populations represented a loss of approximately 18 snails per month. OANRP met with USFWS and Dr. Hadfield to discuss plans to bring snails into the lab for temporary safe-keeping despite recent lab problems until a more permanent snail enclosure could be built. First, a total of 50 genetic samples were collected to determine that the snails there all showed similar genetic composition and could be included in the same enclosure. Over the next four months a total of 202 *A. mustelina* were collected, primarily from the areas that would be impacted by tree cutting to make room for the enclosure. This number of adults collected is higher than our population status table reflects for the number of matures. This discrepancy is due to staff time spent searching. A great deal more time was expended searching for snails to collect for the lab and staff climbed into tree canopies to find as many as possible within the proposed enclosure site.

OANRP spent two camping trips consisting of approximately 280 person hours clearing vegetation in preparation for enclosure construction. The canopy at KAL-A is dominated by huge *Schinus terebinthifolius*. OANRP were concerned that these trees could drop limbs and compromise the future enclosure perimeter. In addition, these trees were competing with native vegetation. See the photos below of clearing efforts. OANRP have concerns that eliminating too much of the canopy would increase the amount of light and heat exposure for host trees containing *A. mustelina*. Thus OANRP are writing a restoration plan while clearing continues.

Photos of clearing for Puu Hapapa exclosure



The table below shows the 202 snails that were collected and brought into the lab for captive rearing. Snails were collected on four separate occasions; twice in February, once in April and once in May. Until the genetic analyses were complete the snails were kept in separate terraria.

j = juvenile = < 8mm in length

s = subadult = > 8mm but not having a lip to signify reproductive adult

a = adult = having a lip to signify reproductive adult

***Achatinella mustelina* Puu Hapapa Laboratory Population Numbers 2010**

Population numbers by month	February	March	April	May	June	July	August
Field Site	j/s/a	j/s/a	j/s/a	j/s/a	j/s/a	j/s/a	j/s/a
Ieie	8/1/9	17/13/16	21/13/16	22/13/16	21/13/16	25/13/16	25/13/16
Outplant 1	12/10/19	16/13/15	21/13/14	26/12/14	28/12/14	27/12/14	27/12/14
Outplant 2	11/11/18	17/12/15	16/12/15	20/12/15	22/12/14	21/12/13	21/12/13
Shelter	11/0/10	18/14/15	23/14/15	26/14/15	27/14/15	30/14/14	30/14/14
Puu Hapapa 5	--	--	--	--	8/26/14	13/26/14	13/26/14
Total live at end of period	120	181	193	205	256	264	264
Deaths by size	0/0/0	3/0/1	4/0/1	4/1/0	6/1/1	4/0/2	0/0/0
Total Deaths	0	4	5	5	8	6	0
Total Births	0	18	17	17	16	14	0

ESU D2 Makaha


Based on the table presented in last year's report comparing Makaha and Puu Kalena, and the IT's recommendation, OANRP plan to manage Makaha for ESU D2. OANRP have observed a total of 130 *A. mustelina* at Makaha within the fence enclosure and its borders. A camping trip is planned for October 2010 when snail surveys will be conducted and the rat baiting grid set up.

***Achatinella mustelina* in Makaha ESU-D2 Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
MAK-A Isolau ridge	Manage for stability	46	2009/06/17	27	7	12	0	Yes	Partial	No	No
MAK-B Kumaipo ridge crest	Manage for stability	21	2010/01/19	16	2	3	0	Yes	Partial	No	No
MAK-C Near pinnacle rocks. Includes Hesarb ridge.	Manage for stability	15	2010/01/21	13	1	1	0	Yes	No	No	No
MAK-D On ledge below ridge crest above MAK-A site.	Manage for stability	48	2009/06/18	34	10	4	0	Yes	No	No	No
MAK-E Ridge east of Cyasup enclosure	Manage for stability	36	2009/06/18	28	6	2	0	Yes	Yes	No	No
ESU Total :		166		118	26	22	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

 = Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- Performed thorough surveys in two areas and obtained current snail numbers. There was a slight increase in snails observed from 89 total presented in last year's report to 166 total incorporating this year's new data.
- Conducted weed control in areas where *A. mustelina* is known.
- OANRP coordinated with rat researcher, Aaron Shiels, from the University of Hawaii during his work at Makaha. Makaha was used to compare rat density and range to the Kahanahaiki study site. The results of this project will be presented in a PhD dissertation in November 2010.

Plans for Year 7

- Install ground shell plots at sites in Makaha.
- Install predator control in Makaha following USFWS notification of diphacinone use per the pesticide label.
- Continue comprehensive snail surveys within Makaha MUs.
- Conduct weed control at manage for stability sites within this ESU.

4.2.5 ESU-E Puu Kaua/Ekahanui

No new surveys were conducted during this reporting period; therefore, the numbers of snails reported this year are identical to last year. The table below summarizes the current population numbers for each reference code within this ESU. Rat management is underway at all the known ESU-E sites with the exception of EKA-D and EKA-F. Snail surveys are scheduled for September 2010 to update population count.

Achatinella mustelina in ESU-E Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
EKA-A Mamane Ridge and Near Plapripri EKA-A	Manage for stability	183	2004/10/13	93	30	60	0	Yes	No	Yes	No
EKA-B Below north population of Tetlep. Between Plapri EKA-A, EKA-B and EKA-C	Manage for stability	55	2004/10/14	46	6	3	0	Yes	No	Yes	No
EKA-C At Plapripri EKA-C site	Manage for stability	6	2004/10/14	6	0	0	0	Yes	No	Yes	No
EKA-D Puu Kaua	Manage for stability	202	2004/10/12	158	31	13	0	Yes	No	No	No
EKA-E Amastra site	Manage for stability	13	2004/10/05	9	3	1	0	Yes	No	Yes	No
EKA-F from Plapri-C head along blue trail under cliffs mauka	Manage for stability	3	2006/02/01	2	1	0	0	Yes	No	No	No
EKA-G Cenagr	Manage for stability	2	2008/04/10	1	1	0	0	Yes	Yes	No	No
ESU Total :		464		315	72	77	0				

Size Class Definitions

Size Class	Def Size Class
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

= Threat to Taxon at Population Reference Site
 No Shading = Absence of threat to Taxon at Population Reference Site
 Yes=Threat is being controlled at PopRefSite
 No=Threat is not being controlled at PopRefSite
 Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- Completed the Ekahanui Subunit II fence construction.
- Conducted weed control at sites with *A. mustelina*.
- Monitored ground shell plot and no rat predation observed.

Plans for Year 7

- Monitor ground shell plot.
- Deploy rat snap trap grid across Ekahanui MU which will protect six of the seven population reference sites listed in the table above.
- Remove pigs from Subunit II fence.

- Contractor to conduct rat control every other week year-round to protect *A. mustelina* within this ESU.
- Perform thorough surveys in all known areas and obtain current snail numbers.

4.2.6 ESU-F Puu Palikea/Mauna Kapu (Palehua)

The Puu Palikea fence encompasses most of the known *Achatinella mustelina* locations within this ESU. There are over 300 total snails protected within this MU fence and snap trap grid.

Achatinella mustelina in ESU-F Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
<i>Achatinella mustelina</i>											
MAU-A Mauna Kapu (Palehua)	Manage for stability	40	2010/05/11	26	9	5	0	No	No	Yes	No
PAK-A Puu Palikea-Ohla spot	Manage for stability	29	2008/04/22	26	0	3	0	Yes	Yes	Yes	No
PAK-B Iele Patch	Manage for stability	1	2008/10/29	1	0	0	0	Yes	Yes	Yes	No
PAK-C Steps spot	Manage for stability	33	2008/08/14	19	9	5	0	Yes	Yes	Yes	No
PAK-D Joel Lau's site	Manage for stability	20	2008/09/23	15	5	0	0	No	No	Yes	No
PAK-E Exogau site	Manage for stability	4	2006/05/22	3	0	1	0	Yes	Yes	Yes	No
PAK-F Dodonaea site	Manage for stability	5	2008/04/22	5	0	0	0	Yes	Yes	Yes	No
PAK-G Hame and Alani site just above Cyagri fence	Manage for stability	30	2006/01/25	13	11	6	0	Yes	Yes	Yes	No
PAK-H Mike Hadfield's study site at Puu Palikea	Manage for stability	19	2010/05/12	10	4	5	0	Yes	Yes	Yes	No
PAK-I One ridge truck side of E and F	Manage for stability	5	2006/01/26	4	0	1	0	No	No	Yes	No
PAK-K Pilo site	Manage for stability	36	2009/03/25	29	5	2	0	Yes	No	Yes	No
PAK-L Olapa site north of Puu Palikea	Manage for stability	32	2008/09/25	28	3	1	0	Yes	Yes	Yes	No
PAK-M Middle site	Manage for stability	208	2009/09/23	151	40	17	0	Yes	No	Yes	No
ESU Total :		462		330	86	46	0				

Size Class Definitions
SizeClass **DefSizeClass**
 Large >18 mm
 Medium 8-18 mm
 Small < 8 mm

■ = Threat to Taxon at Population Reference Site
 No Shading = Absence of threat to Taxon at Population Reference Site
 Yes=Threat is being controlled at PopRefSite
 No=Threat is not being controlled at PopRefSite
 Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on *A. mustelina*.

Major Highlights/Issues Year 6

- Initiated new population counts at three of the 13 population reference sites within this ESU. In the future we will conduct these counts within one quarter.
- OANRP continued monitoring three ground shell plots in ESU-F and the presence of *O. alliarius*, the predatory garlic snail, has been confirmed.

Plans for Year 7

- Complete population counts at population reference sites that were not surveyed last reporting period.
- Install MU scale snap trap grid across Puu Palikea MU.