

3.0 *ACHATINELLA MUSTELINA* MANAGEMENT

***Achatinella mustelina* MIP requirements**

The Final Makua Implementation Plan 2003 (final MIP) contains a stabilization plan for *A. mustelina*. The strategy for management outlined in this stabilization plan was based on unpublished genetics studies that were underway at the University of Hawaii (Holland and Hadfield 2003). Since the Implementation Plan was finalized, these genetic studies were published (Holland and Hadfield 2002). The final results in this publication differ from the unpublished results used to build the stabilization plan for *A. mustelina*. Both studies are based on the concept of Ecologically Significant Units or ESUs. Each ESU is considered a genetically distinct group. In order to reach stability for *A. mustelina* the Army needs to ensure that threats at each of these ESUs are managed. In the unpublished paper, eight ESUs were identified but in the published paper there were only six. This discrepancy was discussed at a snail subcommittee meeting of the Makua Implementation Team on 12 May 2004 and the group was in agreement that the published paper should be the basis for the stabilization plan. This means that the Army's requirement is to manage the six ESUs identified in Holland 2002. The Army will still manage two sites within the geographically large ESUs (ESU B and ESU D) as stated in the final stabilization plan for *A. mustelina* in order to represent the extreme ends of the ranges for these ESUs. The revised stabilization plan for *A. mustelina* reflecting ESU changes is below.

***Achatinella* Stabilization Plan Summary**

Long Term Goals:

- Manage snail populations at 8 field locations to encompass the extant range of the species and to include all 6 genetically defined evolutionarily significant units (ESUs).
- Achieve at least 300 snails per population.
- Maintain captive populations for each of the 6 recognized ESUs.
 - Control all threats at each managed field location.

Table 3.1 Field Sites for Stabilization Efforts

New ESU	Old ESU	Site No.	Location	# of Snails in the Final MIP	Final MakuaIP Year 1 Recommended Actions	Revised Year 1 Recommended Actions
A	A	1	Kahanahaiki	55	Manage for stability (choose between Kahanahaiki and Pahole)	Manage for stability (together with Pahole)
A	A	2	Pahole	50+	Manage for stability (choose between Kahanahaiki and Pahole)	Manage for stability (together with Kahanahaiki)
A	A	3	Kapuna	~25	None	None
B	B	4	Ohikilolo	300+	Manage for stability; Collect for captive propagation	Manage for stability
B	B	5	Central Makaleha (culvert 39)	81	Select one of 3 candidate sites for management (site # 5, 6 or 7)	None
B	B	6	East Makaleha (culvert 45)	29	Select one of 3 candidate sites for management (site # 5, 6 or 7)	None
B	B	7	East Makaleha (culvert 67)	40	Select one of 3 candidate sites for management (site # 5, 6 or 7)	None
B	N/A	N/A	East Makaleha (culvert 69)	83	None	Manage for stability
C	C	8	Schofield West Range/ Haleauau	18	Manage for stability; Collect for captive propagation	Manage for stability
C	D	9	Alaiheihe	25	Survey; Collect for captive propagation	None
C	E	10	Palikea Gulch	7	Survey; Collect for captive propagation	None
C	N/A		Manuwai Gulch	?	None	Survey for substantial population for management. If found abandon Hale'au'au.
D	F	11	Waianae Kai (2 sites)	12	Survey for manageable population	None
D	F	12	Waianae Kai	20	Survey for manageable population	None
D	F	14	Puu Hapapa	36	None	None
D	F	15	Schofield South Range	32	Select one of 2 candidate sites for management (site # 15 or 16)	None
D	F	16	Kaluaa and Waieli	50	Survey for manageable population; Select one of 2 candidate sites for management (site # 15 or 16)	Manage for stability
D	N/A	19	Makaha	17	Determine management after genetics analysis is completed	Manage for stability

New ESU	Old ESU	Site No.	Location	# of Snails in the Final MIP	Final MakuaIP Year 1 Recommended Actions	Revised Year 1 Recommended Actions
D	N/A	20	Mohiakea	10+	Determine management after genetics analysis is completed	None
D	N/A	21	Puu Kumakalii	~20	None	None
D	N/A	22	Central and North Kaluaa	5 (seen incidentally)	Determine management after genetics analysis is completed	None
E	G	17	Puu Kaua (Ekahanui)	12	Survey for manageable population; Collect for captive propagation	Manage for stability
E	N/A	23	Huliwai	30+	Determine management after genetics analysis is completed	None
F	H	18	Puu Palikea	~40	Manage for stability; Collect for captive propagation	Manage for stability

3.1 Captive Propagation

One of the requirements outlined in the MIP stabilization plan is to represent in captive propagation snails from each of the six ESUs and from the two extra sites in ESU-B and ESU-D. All but one site is represented and the snails are prospering at Dr. Hadfield's laboratory at the University of Hawai'i. Detailed snail captive propagation data are included in Attachment 1. In reviewing these data it appears that eight lab populations from 7 field sites that are designated as manage for stability are still growing in the laboratory. The MIP stabilization plan states that lab populations should be refreshed with wild stock if the lab population remains small or declines in numbers. In addition, it states that lab populations should be refreshed every two years and lab-reared snails rotated back out into the wild. NRS have concerns about the potential drain on the field population and the potential for lab borne pathogens to harm the wild population.

3.2 ESU Updates

3.2.a ESU A (Pahole to Kahanahaiki)

Table 3.2 Number of snails counted from ESU A

Pop Ref Code	No. Snails as of 8/04	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
MMR-A Kahanahaiki Exclosure	70	50	20		X	X	X	X
MMR-B Pahole Exclosure	39	39			X	X	X	X
MMR-C Maile Flats	157	117	32	8	X	X	X	X
TOTAL	266	206	52	8				

This table shows the number of snails, size classes, and threats to the snails in ESU A. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management for ESU A is well underway. This ESU encompasses a relatively flat forest area in the uppermost reaches of Kahanahaiki Valley. This area is dominated by *Acacia koa* and *Metrosideros polymorpha*. *Nestigis sandwicensis* is a common canopy tree in this area and is favored by *A. mustelina*. Two exclosures were constructed to protect snails from rats and *Euglandina rosea*. The numbers of snails in these exclosures from recent observations are shown above as MMR-A and MMR-B. MMR-C is the area between the two existing exclosures called “maile flats”. *A. mustelina* from ESU-A are represented at the U.H. Tree Snail Laboratory.

3.2.a.1 MMR-A (Kahanahaiki Exclosure)

For a detailed description of the Kahanahaiki snail exclosure, see PCSU Report 2003. NRS continue to maintain and monitor the Kahanahaiki exclosure by re-stocking salt troughs, ensuring the electrical barrier is functioning and conducting rat control outside the exclosure. Rat control is conducted just outside the perimeter because rat damage on *N. sandwicensis* fruit has been observed inside the exclosure in past years. Bait is not placed within the exclosure because NRS do not want to provide any attractant that may encourage rats to cross the barrier. Rat control has been conducted regularly since 2001 and a total of six bait station and 12 snap traps are deployed.

Table 3.3 Kahanahaiki Snail Exclosure Rat Information

Year	Rats Snapped	% Take	Bait Taken	Bait Available
2001	1			
2002	3	84%	404	479
2003	5	72%	647	896
2004	11	75%	533	706

The Kahanahaiki enclosure design has some flaws. The enclosure is not impenetrable to rats but does seem to be keeping out *Euglandina rosea*. The current design requires significant overstory clearing along the perimeter of the enclosure, which has created a drier environment within the enclosure. NRS have discovered *A. mustelina* in the salt trough of the snail enclosure; it is unclear if these snails were trying to enter or exit the enclosure. The electrical barrier is often not functioning properly because of rain or shorts in the system and requires monthly monitoring. NRS will investigate enclosure design modifications to address these issues before constructing any new enclosures.

NRS attempt to conduct an *A. mustelina* census each summer within the enclosure. This year a mark-recapture study was conducted inside the enclosure. On the 6 May 2004 survey, 68 snails were counted and marked. On the re-capture survey of 14 July 2004, 70 snails were counted, only 37 of which were observed to have marks from the original count. This potentially indicates a much larger number of snails in the enclosure than were counted, but because it is likely that the paint used to mark the snails wore off before the second count, further studies need to be done. At this time, NRS are only comfortable saying there are 70 snails in the enclosure.

3.2.a.2 PAH-A (Pahole Enclosure)

For a detailed description of the Pahole snail enclosure, see PCSU Report 2003. The Pahole snail enclosure is located on the Pahole side of the boundary between Makua Military Reservation and the State of Hawai'i's Pahole Natural Area Reserve. This site protects what remains of the population, which University of Hawai'i researchers have been studying for over 20 years. On 27 May 2004, a total of 39 *A. mustelina* were counted. *Euglandina rosea* has penetrated the enclosure barriers in the past killing *A. mustelina*. Significant predation was documented and live *E. rosea* were found within the enclosure. Over the past year NRS have been assisting the State of Hawai'i with maintenance of this enclosure. No additional surveys have been conducted at this site.

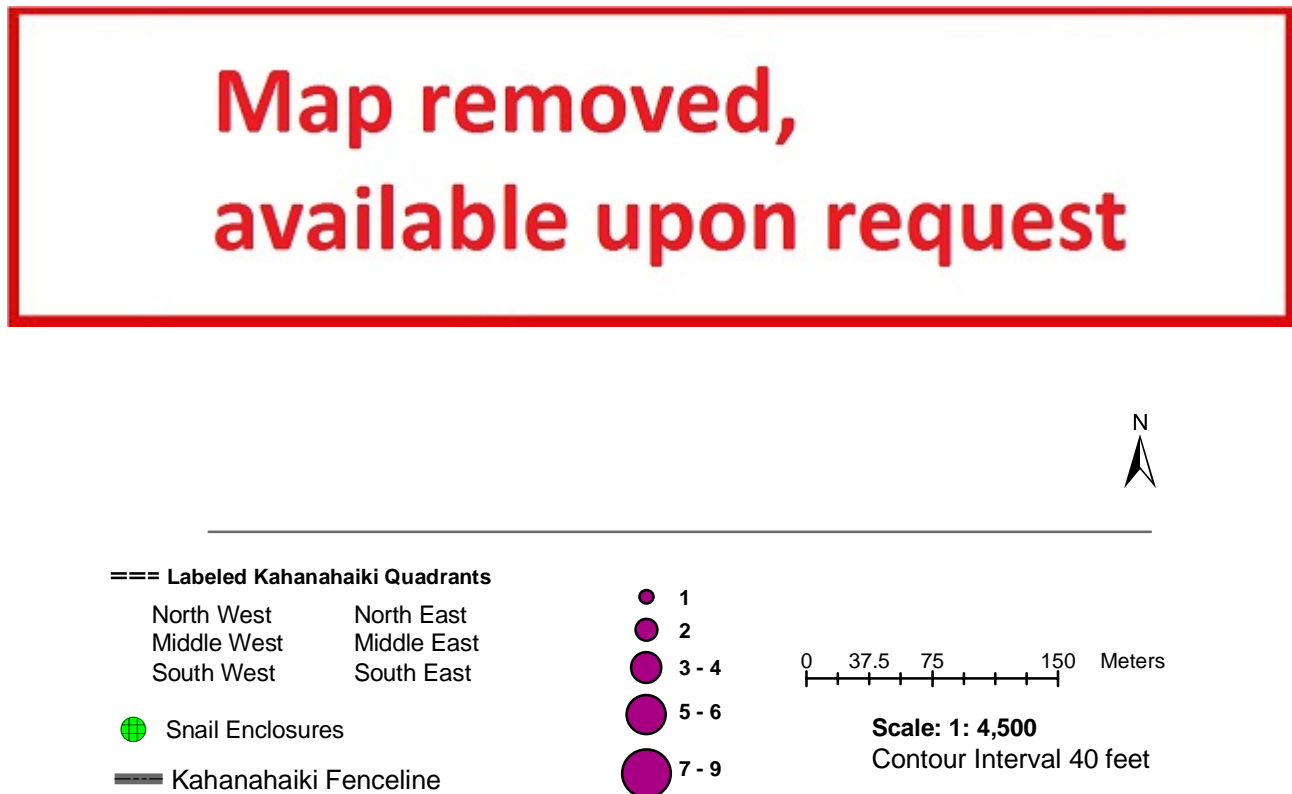
3.2.a.3 MMR-C (Maile Flats)

NRS conducted a thorough survey of the Maile Flats area this summer to determine if there are any large concentrations of snails outside the existing enclosures. NRS surveyed each of six quadrants that were installed for facilitating weed control efforts in the area. The results of this survey are described below and displayed spatially on the map (Figure 5.5).

A. mustelina is most dense in the area just outside the Kahanahaiki snail enclosure and to the south into the Southeast and Southwest quadrants. One hundred and thirty-three person hours were spent searching trees in the Maile Flats area for live *A. mustelina*. Another 8 hours were spent conducting ground searches for evidence of predation in order to determine what threat control is needed. No evidence of recent rat or *E. rosea* predation was observed. However, evidence of significant historical *E. rosea* predation was found, mainly within small, scattered patches of *Pisonia sandwicensis*. Over 50 old, empty *A. mustelina* shells of varying size classes and a number of old, empty *E. rosea* shells were found centered within these *P. sandwicensis* patches. Perhaps *A. mustelina* is easier for *E. rosea* to track within these patches because of the large leaf size of these plants. Or perhaps *A. mustelina* reached high densities on *Pisonia*

sandwicensis. Further study of this unique situation could provide insight into *E. rosea* feeding strategy and may help in determining where *Achatinella* are most susceptible to predation.

Figure 3.1 ESU A/ Population MMR C



One live *E. rosea* was exterminated in the Middlewest quadrant near the Kahanahaiki snail enclosure. There is some concern among NRS that rat control designed to take predatory pressure off *A. mustelina*, may also relieve pressure on *E. rosea* and at the same time may serve as an *E. rosea* attractant. Further investigation should be done to ensure that by trying to control one predator we are not inadvertently increasing the numbers of the other.

The results of this survey show that *A. mustelina* is still abundant in areas outside the MMR-A and PAH-A enclosures. NRS will continue to monitor the high-density areas within the Southeast, Southwest and Middlewest quadrants for evidence of predation. NRS will respond by installing a rat predator control grid if evidence of rat predation is observed. NRS recently made contact with a graduate student from the University of Hawai'i who is interested in studying *E. rosea*. We will encourage him to follow-up on the observations that were made while

conducting these surveys and to develop control techniques for *E. rosea* that may be implemented on a large-scale.

3.2.b ESU B1 (Ohikilolo)

ESU B is very large. Based on Holland's 2002 genetic studies it stretches from East Makaleha to Ohikilolo Ridge. Because of this large range, two sites have been chosen within the ESU for management. These two sites are at the extreme ends of the ESU perimeter; they are the East Branch of East Makaleha (B2) and Ohikilolo (B1). The habitat present at these two sites is very different. See 3.2.c. ESU B2 for a description of the E. Makaleha site. Most of the snails found on Ohikilolo ridge are located within the Ohikilolo Forest Patch. This forest area is dominated by *Acacia koa* and *Metrosideros polymorpha*. *Myrsine lessertiana* is also a common canopy tree on Ohikilolo and is favored by *A. mustelina*. *M. lessertiana* underwent a dieback 3-5 years ago and is still recovering. Other common native trees at Ohikilolo preferred by *A. mustelina* are *Melicope* spp. and *Freycinetia arborea*. The number of snails and threats at each of these sites are presented in the tables below. *A. mustelina* from ESU-B1 are represented at the U.H. Tree Snail Laboratory. Rat control on Ohikilolo has always shown a pattern of high rat bait take. This is mainly because we only visit the site once every three months via helicopter because of the remote nature of Ohikilolo. This high-take pattern should be considered when designing and expanding rat baiting grids in order to compensate for the long period of time between visits.

Table 3.4 Number of Snails Counted at Ohikilolo

Pop Ref Code	No. Snails	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
MMR-E Ohikilolo Mauka	77	62	8	7	X	X	X	
MMR-F Ohikilolo Makai	210	166	22	22	X	X	X	
MMR-G Alemac Site	24	20	4		X	X	X	
MMR-H Ohikilolo Koi`ahi Prikaa Reintro Site	16	9	7		X	X	X	?
MMR-I Hedpar MMR-B	2	2			X	X	X	X
TOTAL	329	259	41	29				

This table shows the number of snails, size classes, and threats to the snails in ESU B1. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

3.2.b.1 MMR-E (Ohikilolo Mauka)



The Ohikilolo Mauka population encompasses the full area in the main forest patch "mauka" of the landing zone. NRS observed significant rat predation at this site and began controlling rats in 1999. The rat control currently being conducted is centered on a high-density snail area and the rare plant *Pteralyxia macrocarpa*. There are a total of six bait stations in this area. *E. rosea* has never been observed at this site. Extensive surveys were conducted in August of 2004 and many snails were discovered outside the existing grid. NRS will continue to monitor for evidence of rat predation and will expand rat baiting based on the August 2004 data. Currently this site is protected from pigs because of the steep cliffs that surround the site. Goats within Makuahave almost been completely removed. Goat numbers are very low and remaining herds reside in

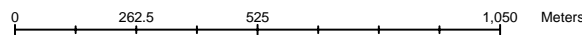
other parts of the valley. No evidence of goat browse has been observed in the last two years. Weed control at this site is extensive and on-going.

Figure 3.2 ESU B1



Legend

- A. mustelina* by Population Code
-  Forest Patch Enclosure
 -  PriKaa A Fence



Scale: 1:12,500
Contour Interval 40 feet

3.2.b.2 MMR-F (Ohikilolo Makai)

The Ohikilolo Makai site consists of the main forest patch “makai” of the landing zone. The core of the *A. mustelina* population on Ohikilolo ridge is located here. NRS have observed significant rat damage to *Prichardia kaalae* fruit near Ohikilolo Makai snails and are currently baiting to protect this fruit year-round. Prior to this summer, no evidence of rat predation on snails had ever been observed at this site. Hence, rat control was never initiated at Ohikilolo Makai. However, comprehensive snail monitoring was conducted at Ohikilolo Makai this summer and eight rat-predated shells were observed at one site. All the predated shells were estimated to be between three and six years old. With this new information, NRS will reconsider the best rat control/monitoring approach for this site. No evidence of *Euglandina rosea* has ever been observed at this site. NRS will continue to monitor for *E. rosea* in Ohikilolo Makai. Care should be taken to ensure that all field gear that has the potential to transport *E. rosea* to the site is strictly inspected. This site is completely protected from ungulates by fencing. Extensive canopy and understory weed control efforts are underway.

3.2.b.3 MMR-G (*Alectryon macrococcus* Site)

MMR-G is located just below the Ohikilolo makai forest patch at the 2,700 ft. elevation. The endangered plant *Alectryon macrococcus* var. *macrococcus* is also located at this site and most of the *A. mustelina* found were observed on these plants. NRS have not observed rat damage to *A. mustelina* at this site although NRS are certain that rats are present in the area. Neither has NRS observed *E. rosea* at this site. NRS will continue to monitor for any signs of predation. Currently this site is protected from pigs by the steep cliffs that surround the site. Threat from goats is minimal as there are few left in Mākua, and those left are found in other parts of the valley. Although some weed control has been conducted at this site, extensive weed control will be more difficult than at the Mauka and Makai sites because of the steep terrain and high density of weed cover.

3.2.b.4 MMR-H (Ohikilolo Koiahi *Pritchardia kaalae* Reintroduction Site)

MMR-H is located at 2200 ft., just below the junction of Ohikilolo and Koiahi ridges. This forest was dominated by *Myrsine lessertiana*, which experienced a large dieback over the last five years. NRS outplanted the endangered plant *Pritchardia kaalae* into this site and have conducted weed control in combination with this effort. Observations indicate that *M. lessertiana* is making a comeback as numerous juveniles are now seen in areas previously dominated by this taxon. NRS have not observed rat damage to *A. mustelina* at this site although NRS are certain that rats are present in the area. NRS will conduct ground searches for *E. rosea* shells at this site in order to determine if it is present. Currently MMR-H is protected from pigs because of the steep cliffs that surround the site. The goats within Makua have almost been completely removed and pose a very low threat to the site.

3.2.b.5 MMR-I (*Hedyotis parvula* MMR-B)

Only two individual *A. mustelina* have been observed at MMR-I, elevation 2,700 feet. They were found in tiny forest pockets on steep cliffs by NRS on rappel. The small forest pockets are dominated by *Metrosideros tremuloides*. This site does not have much management potential as this terrain is too steep and remote to conduct meaningful management. In addition, *Schinus terebinthifolius* is abundant within most small forest pockets in this habitat type. Rats and *E. rosea* are both present at this site, but because of the terrain no ground searches have been conducted for predated shells. The *A. mustelina* habitat at this site has certainly benefited from goat control.

3.2.c ESU B2 (East Branch of East Makaleha)

Table 3.5 Number of Snails Counted in East Branch of East Makaleha

Pop Ref Code	No. Snails as of 6/04	Size Classes			Pigs/Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
LEH-C (culvert 69)	83	83			X		X	?
LEH-D (culvert 73)	19	10	3	6	X		X	?
TOTAL	102	93	3	6				

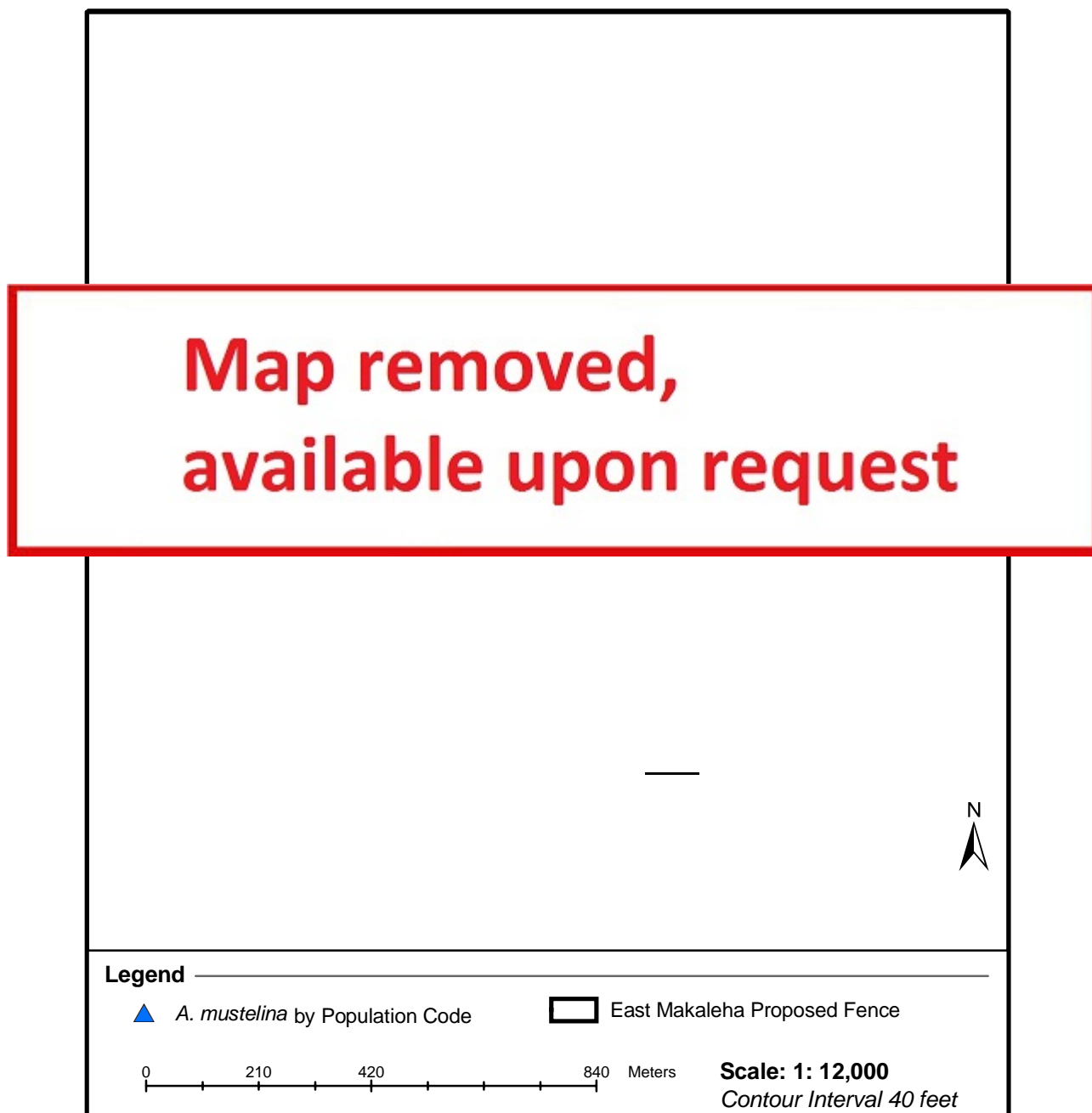
This table shows the number of snails, size classes, and threats to the snails in ESU B2. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

3.2.c.1 Culvert 69

Culvert 69 is off of the Mt. Kaala Access Road. The forest is fairly intact wet forest dominated by *Metrosideros polymorpha* and *Dicranopteris linearis*. *A. mustelina* is found along the crest of the ridge that starts at culvert 69. The ridge crest is moderately steep. It is narrow in most spots, being less than 10 meters wide. The ridge quickly becomes steep off both sides. Very few weedy plant species are found along the section of ridge where *A. mustelina* is found, between 3,000 and 3,400 ft. Little effort has been spent looking for evidence of *E. rosea* and rat predation, but in the limited time spent no evidence was found. NRS will survey the eastern boundary ridge along the Dupont trail within this branch of East Makaleha to determine the presence and abundance of snails there. NRS will expand management of this area by first developing fencing plans. *A. mustelina* from ESU-B2 are represented at the U.H. Tree Snail Laboratory.

3.2.c.2 Culvert 73

Culvert 73 is off of the Mt. Kaala Access Road. The forest is fairly intact wet forest dominated by *Metrosideros polymorpha* and *Dicranopteris linearis*. *A. mustelina* is found along the crest of the ridge that starts at culvert 73. This ridge has similar characteristics as the ridge off of culvert 69. Very few alien plant species are found along the section of ridge where *A. mustelina* is found, between 3,000 and 3,400 ft. Little effort has been spent in the area looking for evidence of *E. rosea* and rat predation, but in the limited time spent no evidence was found. Again NRS will place priority on developing fencing plans for this area and continue to survey to determine abundance and distribution of *A. mustelina* in the area.

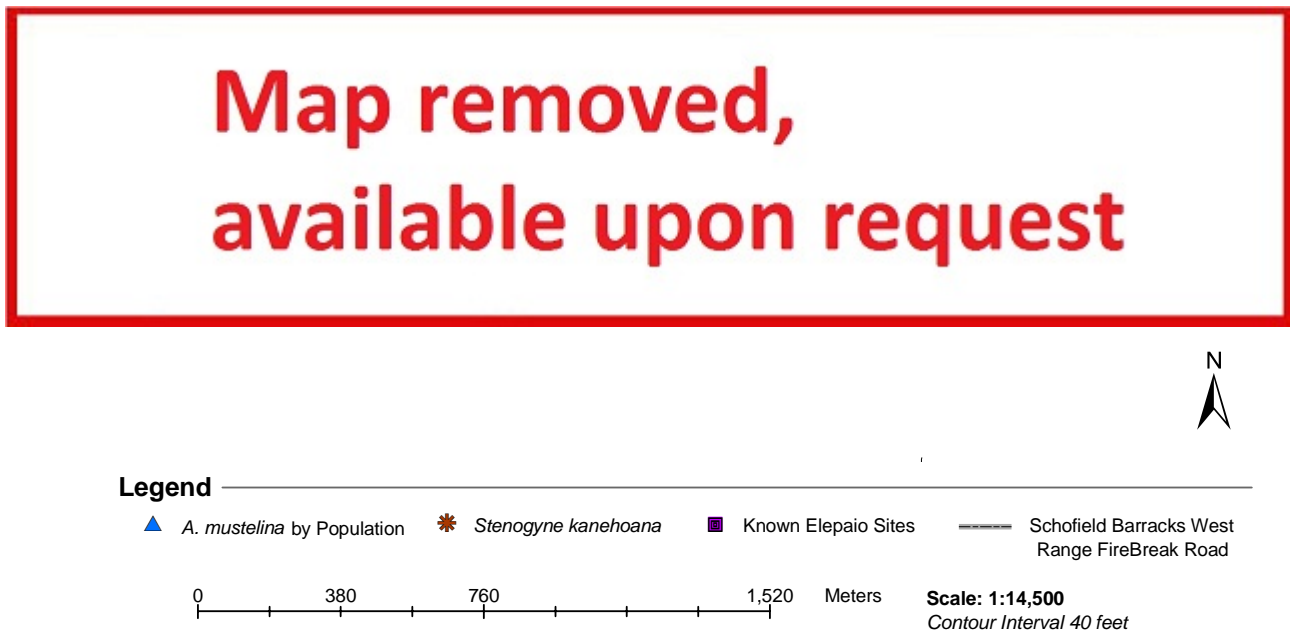
Figure 3.3 ESU B2

3.2.d ESU C**Table 3.6 Number of Snails Counted in ESU C**

Pop Ref Code	No. Snails as of 7/04	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
SBW-A North Haleauau, Hame Ridge	13	13			X	X	X	X
SBW-B North Haleauau, one ridge north of Hame	7	7			X	X	X	X
SBW-C North Haleauau, just above <i>Pouteria</i> pair territory	10	7	3		X	X	X	X
SBW-P Stekaa site	4	2	1	1	X	X	X	X
ANU-A Manuwai Gulch	1	1			X	X	X	X
TOTAL	31	30	4	1				

This table shows the number of snails, size classes, and threats to the snails in ESU C. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management for ESU C is challenging. The numbers of snails found at any one site within the ESU are few and the habitat quality is marginal. Access issues related to steep terrain and Schofield Barracks West Range compound these challenges. ESU-C was not managed prior to the MIP. Originally, the SBW-A, B and C sites were going to be combined into one site for management. Unfortunately, this site is difficult to access because of its location above the Schofield Barracks West Range (SBW) live-fire training area. At the May 2004 MIT snail subcommittee meeting a decision was made to survey the upper reaches of Manuwai gulch to find a manageable population, as this area is already slated for large-scale fencing and unfortunately all appropriate habitat was surveyed and only one snail was found. Other proposals for management are discussed below. There are other sites in ESU-C not shown on the table above that could be revisited, considering current management challenges. *A. mustelina* from ESU-C are represented at the UH Tree Snail Laboratory.

Figure 3.4 ESU C

3.2.d.1 Schofield Barracks West Range-A, B, C, and P

These four sites will be discussed collectively because their situations are similar and related. All of these sites are located in North Hale`au`au gulch between 2,500 and 2,600 ft in elevation. The habitat is infested with pigs. This area is off-limits to hunters, therefore the pig population is growing unchecked. There are no fences installed here. The high pig numbers facilitate the spread of *Psidium cattleianum*, which is a dominant canopy tree in the area. Native forest areas have a very tall canopy in Hale`au`au, which is dominated by *Metrosideros polymorpha*. The subcanopy is composed of *Antidesma platyphyllum*, *Melicope* spp., *Cheirodendron platyphyllum* and *Elaeocarpus bifidus*. This area was proposed for management because the terrain is relatively flat in portions of this ESU and suitable for constructing snail exclosures similar to those in ESU-A. Since these exclosures require intense maintenance, Hale`au`au may not be suitable because of access restrictions. This being said, if management of *A. mustelina* overlapped with management of other species in SBW, then adequate access may be possible to obtain. The O`ahu Biological Opinion (O`ahu BO) mandates that two species must be managed within SBW, *Stenogyne kanehoana* and O`ahu `Elepaio. In this last year, one new *A. mustelina*

site was discovered in the south fork of Hale`au`au in a spot where the other two O`ahu BO taxa are present. This is referred to in the table above as SBW-P. If substantial numbers of *A. mustelina* are found at the SBW-P site, rat baiting could be conducted in conjunction with O`ahu `Elepaio predator control and a fence could be constructed to protect all three species together. Additional surveys in the vicinity of the *S. kanehoana* in South Hale`au`au for *A. mustelina* are recommended. If substantial numbers of *A. mustelina* are found, NRS will collect genetic material so an ESU determination can be made.

3.2.d.2 ANU-A (Manuwai)

Manuwai is one of the gulches in Lower Mt. Kaala Natural Area Reserve (NAR). Lower Mt. Kaala NAR as a whole is characterized by very steep-walled gulches, which limit management options. There are plans for a fence in Manuwai in order to protect some rare plant populations found there. NRS theorized that *A. mustelina* could be managed in combination with these plants in one large fenced unit, however, based on the poor numbers of snails discovered during the survey conducted this year, NRS are re-evaluating again where and how to conduct management for *A. mustelina* in ESU-C. Therefore, the lone snail was not sampled to determine its ESU status. Other sites in Lower Mt. Kaala NAR are available for management. Surveys will be conducted in other gulches within this portion of ESU-C in order to determine if there are populations located in moderate terrain, within a healthy native forest and in areas that overlap with other species the Army must manage.

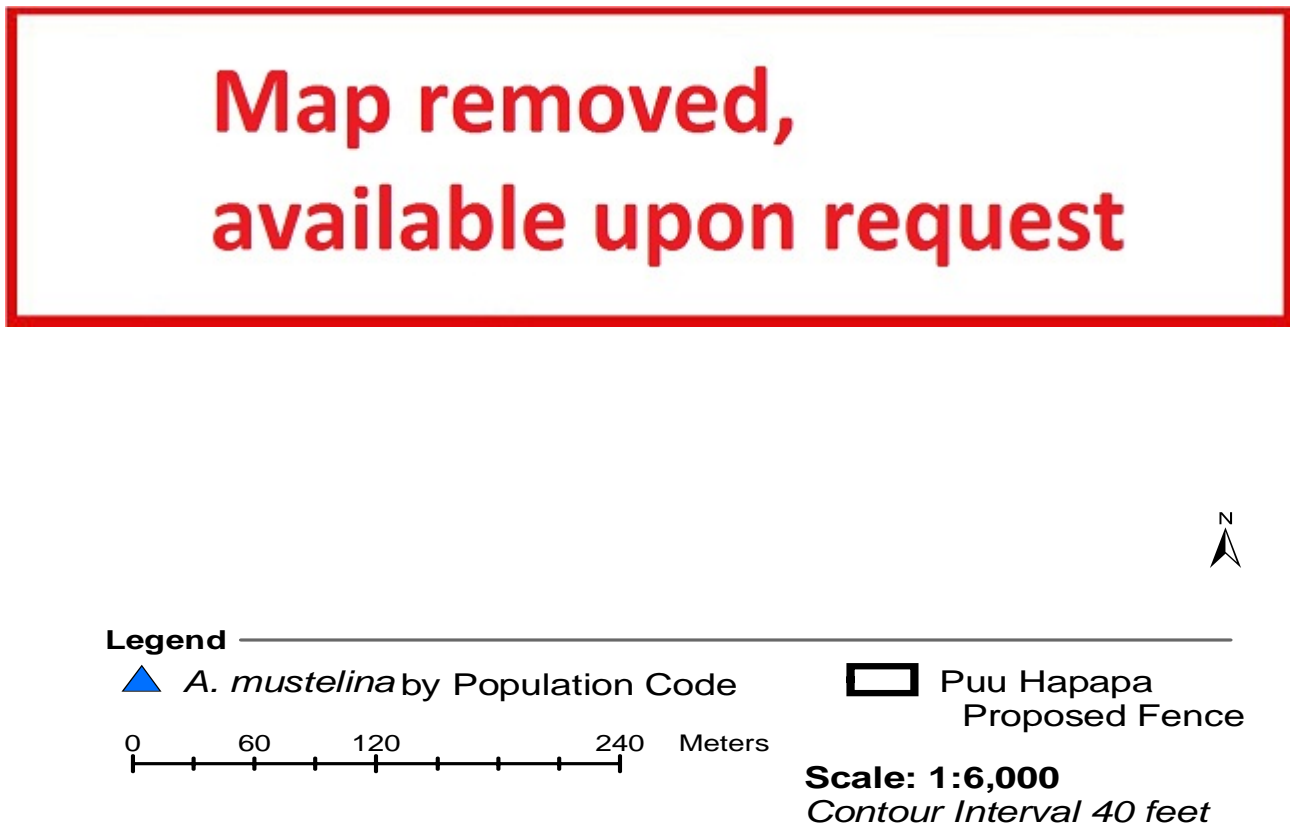
3.2.e ESU-D1 North Kaluaa and Puu Hapapa

Table 3.7 Number of Snails Counted in ESU D1

Pop Ref Code	No. Snails as of 8/04	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
KAL-A Kaluaa and Waielei	481	158	237	86	X	X	X	X
SBS-B Puu Hapapa	196	131	44	21	X	X	X	X
TOTAL	677	289	281	107				

This table shows the number of snails, size classes, and threats to the snails in ESU D1. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

ESU D encompasses a large geographic area. For management purposes it has been split into two portions. D1 includes Puu Hapapa and Kaluaa, and D2 includes Makaha. Management for ESU D1 is promising. The numbers of snails found at both sites is substantial and habitat quality is good. The two sites are continuous and encompass most of the Puu Hapapa summit. Rat baiting is already being conducted at both sites and plans are being developed to protect the ESU from pigs. Weed control is also conducted at both sites. The native species in this ESU preferred by *A. mustelina* include *Freycinetia arborea* and *Myrsine lessertiana*. The native forest canopy is primarily *Metrosideros polymorpha*. Slow growing *Freycinetia arborea* is extremely susceptible to pig damage as it grows low to the ground. ESU D1 was managed prior to the MIP and the number of snails in the area reflects this. *A. mustelina* from ESU-D1 are represented at the UH Tree Snail Laboratory.

Figure 3.5 ESU D1

3.2.e.1 KAL-A, Kaluua and Waieli (Land of 10,000 Snails)

NRS and TNC conducted a joint survey of this site. The total reflected in the table above is the result and shows that this site is one of the most robust in the Wai`anae Mountains. The Nature Conservancy (TNC) has been working here for the last three years, as it is located within the Honouliuli Preserve. They have been administering rat bait to protect snails from rat predation and have been controlling pig populations in the area. TNC stocks 16 bait boxes each month and checks five snap traps near the core of the population. This year the Army funded a full-time field position to work on species covered in Army consultations located on Honouliuli Preserve. This staff person has been assisting with the rat baiting and ungulate control efforts at the Kaluua and Waieli *A. mustelina* site. TNC obtained grant money to obtain fence materials to construct a

fence to protect this site. NRS will assist TNC with this fencing effort. NRS will work with TNC staff to cooperatively maintain the rat bait stations and expand the rat-baiting grid if necessary.

3.2.e.2 Schofield Barracks South Range-B Puu Hapapa

North Waieli gulch is situated within Schofield Barracks South Range (SBS). A portion of Puu Hapapa, which is the peak at the top of Wai`eli gulch, is also a part of SBS. This portion of Puu Hapapa is referred to as SBS-B. NRS have been controlling rats using diphacinone bait atop Puu Hapapa since 2000. This year a total of 172 bait blocks were put out in 8 stations. Rat control also protects two other species of native snails that are found in overlapping habitat at this site. These taxa are *Laminella sanguinea* and *Amastra micans*. On a recent survey to Puu Hapapa NRS counted 196 *A. mustelina* in an area less than 10 acres in size. This portion of Puu Hapapa is very steep, which renders management efforts challenging. For safety, NRS work while on rappel in some areas. Nonetheless, NRS would like to expand the fencing project planned for KAL-A to include as much of SBS-B as possible. Weed control is underway at Puu Hapapa and should directly improve the quality of habitat for *A. mustelina* in the area.

3.2.f ESU-D2 Makaha

Table 3.8 Number of Snails Counted in ESU D2

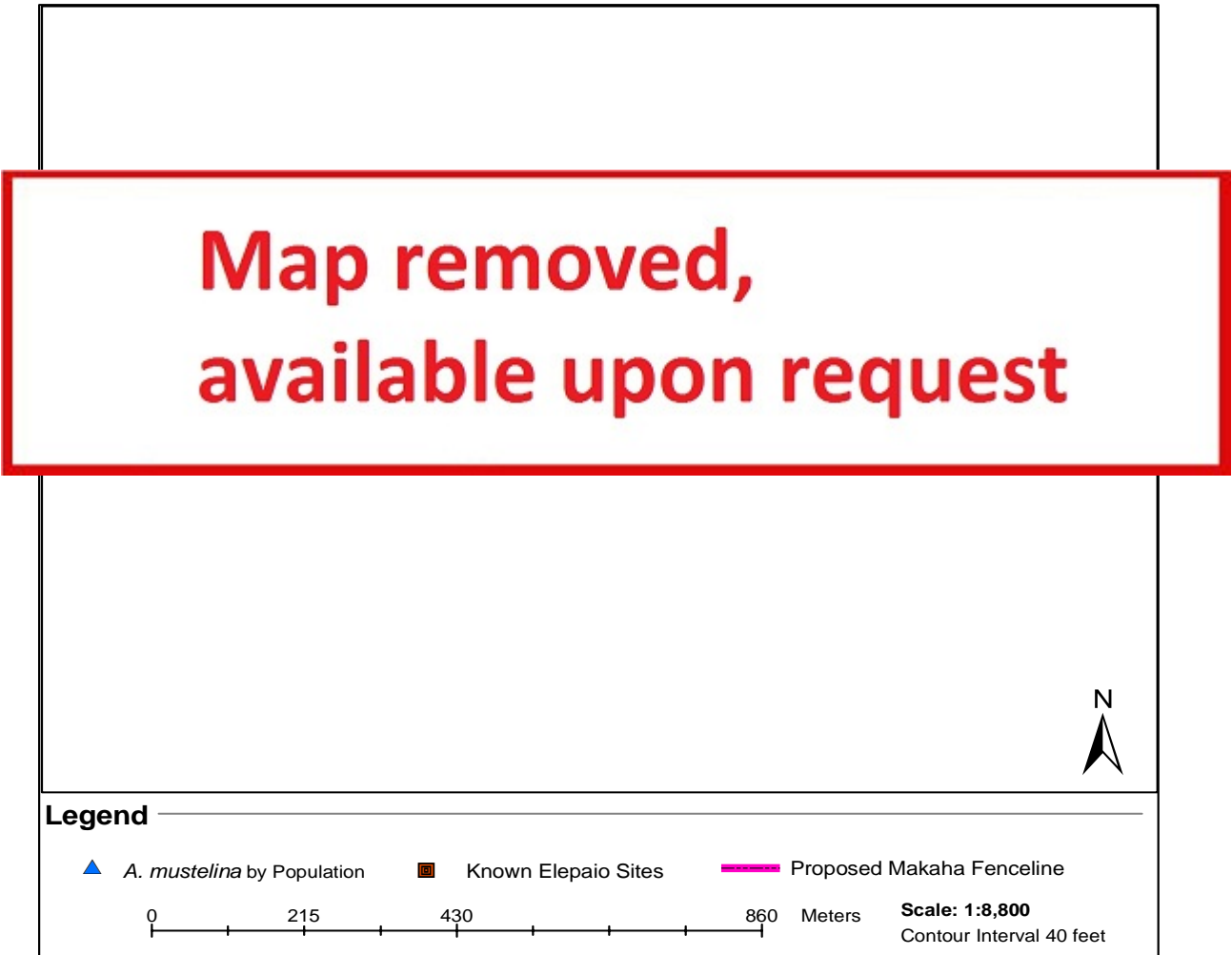
Pop Ref Code	No. Snails as of 7/04	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
MAK-A (Isolau ridge)	53	53			X	X	X	X
MAK-B (Kumaipo ridge crest)	4	3	1		X	X	X	X
TOTAL	57	56	1					

This table shows the number of snails, size classes, and threats to the snails in ESU D2. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management of ESU D2 has been limited thus far. Comprehensive surveys have yet to be conducted in Makaha. In the lower elevation gulches within Makaha (MAK-A), the native canopy is a mix of *Diospyros spp.*, *Antidesma platyphyllum*, *Nestigis sandwicensis* and *Pisonia spp.* The forest canopy near the Kumaipo ridge crest (MAK-B) is dominated by *Acacia koa* and *Metrosideros polymorpha*. The numbers of snails at MAK-A is an old number and needs to be updated. The MAK-B number represents an incidental observation made along a portion of the proposed fence line near the Kumaipo ridge crest. NRS need to conduct methodical surveys to identify hot spots, look for evidence of predation and develop management plans. At this point, most of the staff time spent in Makaha has been planning a large-scale fence project. MAK-A and MAK-B are both located within the proposed fence project. Ungulates are currently having a significant negative impact on the forest within Makaha. NRS have determined the best fence route, flagged the line, determined where strategic fencing is necessary and put together supporting paperwork for the project. The fence will protect 100 acres of mesic forest, most of which is suitable habitat for *A. mustelina*. The fence construction has been funded this year and construction is expected to begin in late Fiscal year 2005. Extensive weed control is required in order to improve the condition of this forest area. The most abundant canopy weeds are *Psidium*

cattleianum and *Schinus terebinthifolius*. The Board of Water Supply has yet to authorize the use of pesticides in Makaha Valley but the issue is being considered. BWS conducts rat baiting between January and June, during the O'ahu 'Elepaio nesting season. This rat control probably benefits the snails found within those 'Elepaio territories, if there are any. *A. mustelina* from ESU-D2 are represented at the UH Tree Snail Laboratory.

Figure 3.6 ESU D2

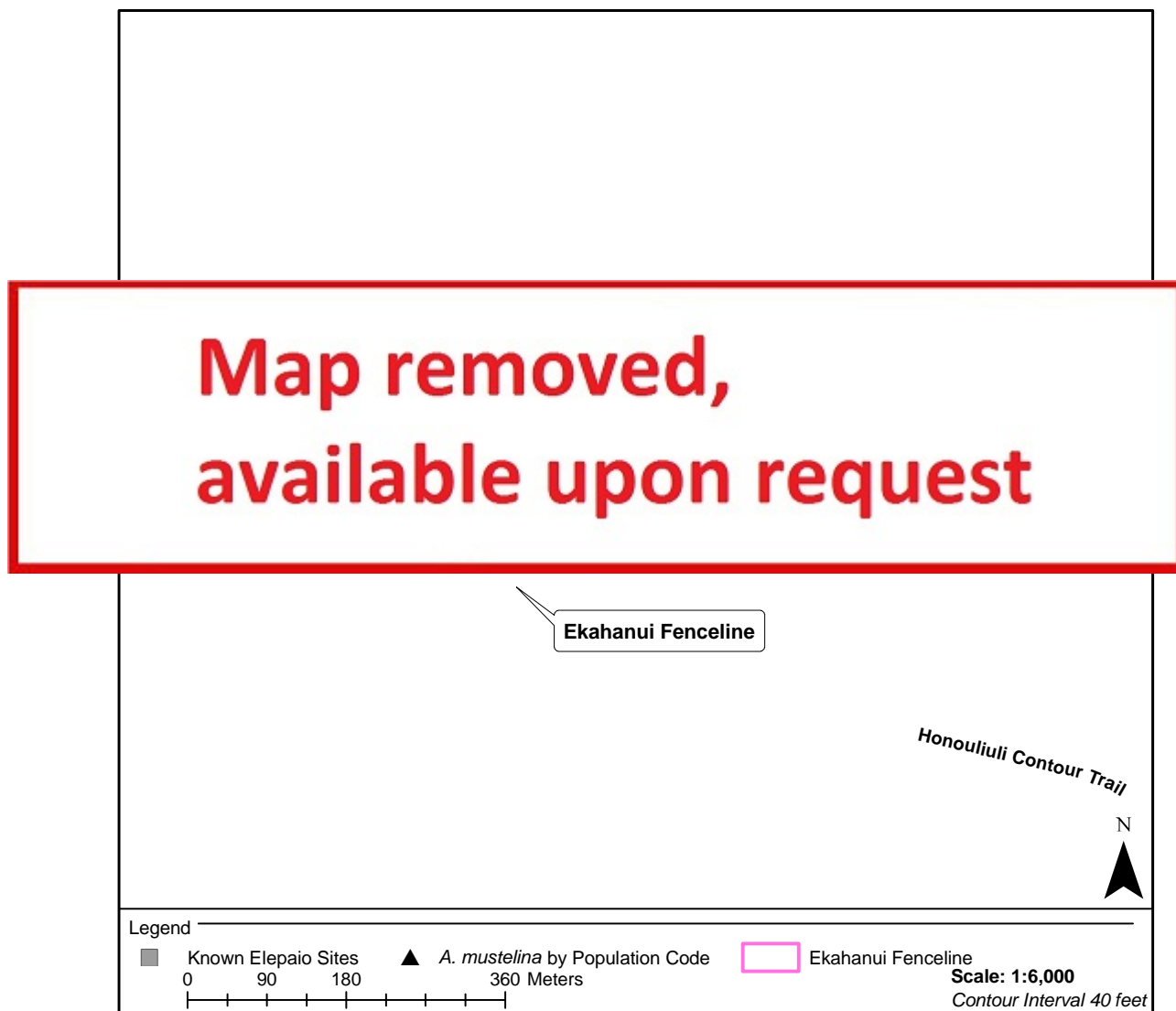


3.2.g ESU-E Puu Kua/Ekahanui**Table 3.9 Number of Snails Counted in ESU E**

Pop Ref Code	No. Snails	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
EKA-A (Mamane Ridge)	25	25			X	X	X	X
EKA-B (Plapri EKA-A site)	29	27	2		X	X	X	X
EKA-E (Amastra site)	5	5						
TOTAL	59	55	2	2				

This table shows the number of snails, size classes, and threats to the snails in ESU E. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management for ESU E has been limited thus far. This ESU encompasses a few large concentrations of snails within the Ekahanui drainage and along the ridge crest above the drainage. The ridge crest forest type is comprised mainly of wet forest species including *Metrosideros polymorpha*, *Metrosideros tremuloides*, *Melicope peduncularis*, and *Dicranopteris linearis*. Most of the snails found in this area are on *Myrsine lessertiana*. Both EKA-A and EKA-B are situated in this type of ridge crest vegetation. The Ekahanui gulch area is a mix of alien and native forest patches. The native vegetation in areas within Ekahanui that have high concentrations of *A. mustelina* consist of *Freycinetia arborea*, *Diospyros hillebrandii* and *Antidesma platyphyllum*. The management of this ESU has been limited so far as NRS are still getting oriented to the area. The Nature Conservancy is currently conducting rat control in the vicinity of an *Amastra spirazona* population. *Achatinella mustelina* do occur in the same habitat (EKA-E). Only two bait stations are currently deployed. In addition, rat control is conducted during the nesting season in the vicinity of Elepaio and this baiting may benefit *A. mustelina* if there are snails nearby. NRS will assist TNC in these efforts. NRS should expand this grid based on comprehensive survey results. An ungulate exclosure that protects approximately 50 acres of forest already exists in the southern fork of Ekahanui, however, only EKA-A and EKA-E are located within this fence. The Army staff person working full-time with TNC is developing plans for additional fencing to protect the remaining portions of Ekahanui gulch and all the snails in EKA-B. Ten snails were collected from the Mamane Ridge site for captive propagation and are doing well at the UH Tree Snail Laboratory (see Attachment 1: Captive snail propagation data). Site KAL-B, located at a population of the endangered plant *Plantago princeps* needs further survey. A comprehensive *A. mustelina* survey should be conducted with knowledgeable TNC staff across Ekahanui in order to determine where the areas of highest density exist, look for evidence of predation and determine management needs.

Figure 3.7 ESU E

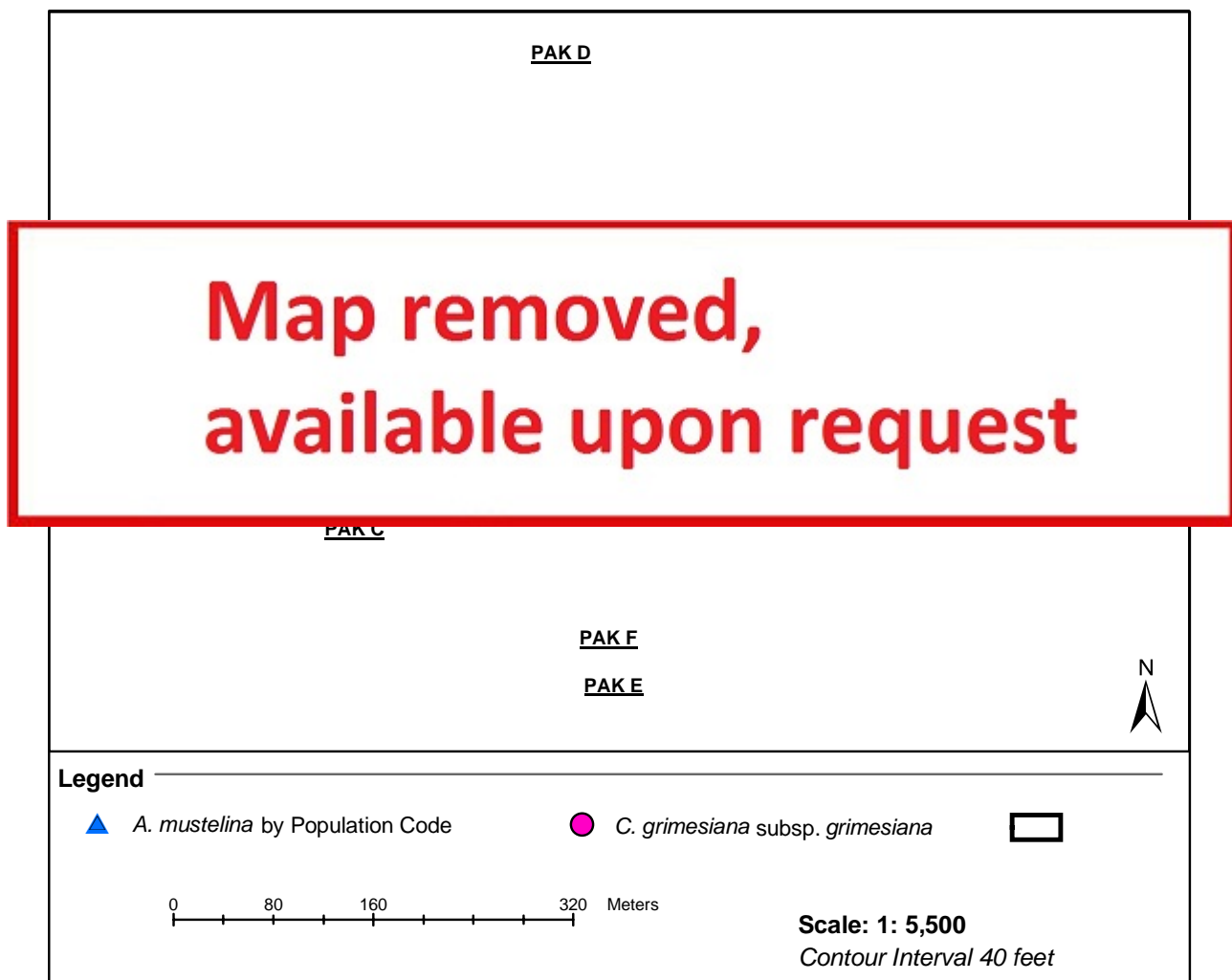
3.2.h ESU-F Puu Palikea

Table 3.10 Numbers of Snails Counted in ESU F

Pop Ref Code	No. Snails as of 8/04	Size Classes			Pigs/ Goats	Weeds	Rats	<i>Euglandina</i>
		Lg	Med	Sml				
PAK-A Puu Palikea Ohia spot	9	5	2	2	X	X	X	X
PAK-B 'Ie'ie Patch	13	11	1	1	X	X	X	X
PAK-C Steps spot	19	14	3	2	X	X	X	X
PAK-D Joel Lau's site	11	8	2	1	X	X	X	X
PAK-E Exogau site	6	4	1	1	X	X	X	X
PAK-F Dodvis Site	5	3	2		X	X	X	X
PAK-G Hame and Alani site just above Cyagri fence	22	13	6	3	X	X	X	X
TOTAL	85	58	17	10				

This table shows the number of snails, size classes, and threats to the snails in ESU F. Shaded boxes indicate that the threat is being controlled, X's indicate that the threat is present. In some cases the threat may be present but not actively preying on *A. mustelina*.

Management conducted to protect ESU F has been limited thus far. Surveys to locate areas of high snail density were recently conducted in order to determine threats and plan management. The snails known from this ESU are scattered in distribution and are shown on the map below. A total of 85 snails were counted in the Puu Palikea vicinity during two days of survey. The habitat quality is good although introduced conifers dominate a large portion of the forest. The native forest in the area is dominated by *Metrosideros polymorpha*. The native plant species at Palikea that *A. mustelina* prefer as host trees include *Metrosideros polymorpha*, *Coprosma foliosa*, *Antidesma platyphyllum* and *Melicope o'ahuensis*. TNC and the Army constructed a fence that is approximately 2.5 acres in size in 1999 to protect an endangered plant, *Cyanea grimesiana* ssp. *obatae*. At this point there are no known *A. mustelina* found within this enclosure but NRS have yet to survey the entire potential habitat within the fence. Weed control is conducted by TNC and the Army liaison to TNC within the enclosure perimeter on a regular basis. Of the 85 snails seen during the recent survey, only 11 were found at an outlier location to the north. Expanding the fence unit at Puu Palikea will protect habitat for the other 74 snails. NRS will make this a high priority action for this ESU. In addition some rat control is underway around the PAK-A, PAK-B and PAK-C snail locations and in the vicinity of the *Cyanea grimesiana* ssp. *obatae*. NRS will work with TNC to expand this predator control effort. *Achatinella concavospira* was also found during the recent survey and will benefit from any management in the Puu Palikea area. Snails collected from this ESU are represented at the UH Tree Snail Laboratory.

Figure 3.8 ESU F

Attachment 1: Captive Snail Propagation Data

Species	Population	ESU	# <i>juv</i>	# <i>sub</i>	# <i>adult</i>	# Individuals
<i>A. mustelina</i>	10,000 snails	D1	8	22	0	30
	Ala'ihe'ihe Gulch	C	14	4	4	22
	Bornhorst		1	1	1	3
	Ekahanui - Hono'uli'uli	E	24	2	3	29
	Ka'ala S-ridge	B2	23	0	6	29
	Makaha	D2	16	0	8	24
	Ohikilolo - Makai	B1	27	0	4	31
	Ohikilolo - Mauka	B1	20	5	0	25
	Palehua	F	3	0	4	8
	Palikea Gulch	C	20	1	8	29
	Peacock Flats	A	8	11	4	23
	Recombined		0	3	0	3
	Schofield		1	4	1	6
	Schofield South Range	D2	18	7	3	28
	Schofield West Range	C	15	1	9	25
	TOTAL					315

Number of snails as of April, 2004

Attachment 2. Grouping of 18 *A. mustelina* sampling sites into 6 ESU's. ESU's A through F show the relative positions of each in the Waianae Mountains of western Oahu. The threshold of genetic distance separating the ESUs was set at 1%. Each population within a given ESU has a pairwise genetic distance to all other populations with the same ESU of 1% or less. Note that the exact shape and extent of each ESU is unknown and therefore the contours depicted are partially theoretical.

**Map removed,
available upon request**