



# Status of Feral Ungulates on Pagan Island, CNMI Marianas Expedition Wildlife Surveys 2010

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**Curt C. Kessler**  
U.S. Fish & Wildlife Service

**STATUS OF FERAL UNGULATES  
ON  
PAGAN ISLAND,  
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS  
MEWS 2010**

**Curt C. Kessler**  
U.S. Fish & Wildlife Service  
Pacific Islands Fish & Wildlife Office  
Honolulu, Hawaii

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Cover picture: Central Pagan Island looking east toward Togari Rock (C.C. Kessler photo)

## Introduction

This report is part of the “Marianas Expedition Wildlife Survey 2010 (MEWS 2010),” a U.S. Fish & Wildlife Service (USFWS) project funded by the Department of Defense - U.S. Marines and is tasked to gather natural resource information on fish and wildlife in the Mariana Islands. This information is required by federal regulations to properly determine the potential impacts that may occur due to the shifting of significant military resources to the Territory of Guam and the Commonwealth of the Northern Mariana Islands. As part of this military buildup, Pagan is under consideration as a live fire training area.

Pagan Island is one of the 14 islands that make up the Commonwealth of the Northern Mariana Islands (18°06'N 145°46'E) and is approximately 320 kilometers north of Saipan. It is the largest of the islands north of Saipan with an area of 47.23 km<sup>2</sup> (18.24 sq mi) and a maximum elevation of 570 m. It consists of two stratovolcanoes joined by an isthmus, both volcanoes have some degree of activity with the northern volcano having erupted in 1981 and is still continually emitting low levels of ash daily. The southern volcano is less active, however steam vents and hot springs are evident.

Pagan had a native Chamorro population until the 1690s when Spanish authorities removed all inhabitants from the Northern or “Gani” Islands. Sometime around 1815 a group of unauthorized colonists from Hawaii tried to establish a settlement which survived for a number of years until they too were removed by the Spanish. Again in 1865 a settlement of about 100 individuals was attempted but abandoned after three years (Russell 1998). Throughout the 1800s until the German period (1898-1914), there are scattered reports of small populations of people on the island, but they appear ephemeral at best with long periods of no population. During the German period the island was developed for copra production with a small population on island to run operations. Copra is the dried meat of coconuts used to make oil and requires laborers to harvest and process. This continued into the Japanese period (1914-1945) and the population continued to grow until its peak in 1945 of about 3000 people (Athens 2008). After World War II the population was removed, but residents were allowed to move back in 1951 (Russell 1998). During the American period (1945-present), the human population once again began to grow to 50-75 during the 1960s and 70s. Peace Corps volunteers were stationed on island to provide residents assistance during this time period. Cattle are known to have been transported to the island as a resource during the American period. Plans were made to develop the island as a tourist destination. All this ended in 1981 when a violent eruption occurred and all residents were removed. No one is currently allowed to “officially” return to their homesteads although 2 or 3 individuals live on island part time.

It is unknown when domesticated animals were first brought to Pagan, but it is not unreasonable to assume that trade with the Spanish resulted in some pigs and/or goats on Pagan in the 1600s.

However these animals would have been prized possessions and probably closely monitored and brought off the island when the people were removed. The first mention of feral animals is in 1825 from the whaling ship *Mentor* which stopped at Pagan and reported an abundance of hogs, which they speculated were left over from the attempt at colonization ten years earlier (PMB 385). By the 1860's whaling ships were stopping by Pagan to pick up pigs along with coconuts and wood (PMB 221). Corte (1870) reported pigs on Pagan while Marche (1891) mentioned both pigs and goats when he was there in 1882. Undoubtedly during the German and Japanese administrations, when the island was being developed for copra production, all manner of domesticated animals were brought to the island including pigs, goats, and cattle. However, during World War II, Pagan was bypassed and no supplies reached the island. The large garrison and farming population were on the verge of starvation, which must have effectively stopped any expansion of feral livestock. After the war, as people moved back, there are reports of goats and cattle being brought to the island in the 1960s. The goats apparently were set free to propagate but the cattle were fenced and closely monitored (Athens 2008). Pigs were presumably already feral, although there is a verbal report of pigs being introduced to the southern end in 1975. The same source states that goats were introduced to the southern end in 1959 (CNMI-DFW 1993). The volcanic eruption in 1981 and subsequent removal of island residents, is the starting point of the current feral animal problem. The livestock were abandoned and went feral and no one has since returned to control the situation. By 1990 there were enough feral cattle for CNMI-Division of Fish & Wildlife (CNMI-DFW) to be concerned and an attempt was made to cull or otherwise control their numbers. This was contested in court by the Castro family who claimed the cattle. They won their case and any attempt at reducing cattle numbers was stopped. At that same period, CNMI-DFW experimented with a solar powered electrical fence to keep cattle from trampling the lakeside vegetation. This was apparently an attempt at saving moorhen and reed-warbler habitat although it is believed these species were exterminated during the eruption. Due to lack of maintenance this fence was a failure and the attempt was halted (CNMI-DFW 1993). Today the Castro family still claims ownership of the cattle, but realizes there is a problem and only asks that those who want to harvest some cattle contact them for permission. This is usually done through the Northern Islands Mayor's Office (NIMO). Currently the islands forests and grasslands are in a state categorized as "severely overgrazed" due to the abundance of cattle, goats, and pigs. This is reflected in the poor physical condition of the feral animals observed on island as shown by necropsies. It is further supported by the lack of native ground cover, senescence in the forest, and a distinct browse line.

## **Methods**

### *Cattle (Bos taurus)*

Cattle were visually surveyed by helicopter. Three spotters as well as the pilot participated. The helicopter was between 50 and 100 meters in altitude. When animals were observed, they were counted and noted on a map. Each section of the island was searched except for the south end

which has no cattle at this time. The island was broken into sections based on terrain. The helicopter would circle a section until the spotters were satisfied that all cattle were counted in that area. Cattle were individually noted and an effort was made to keep track of cattle movements so as not to count them twice. The number of cattle counted was used as the minimum population estimate for the island. Although it is believed that almost all cattle were counted during the survey it's possible that cattle in forested areas may have been missed during the survey. To account for these missed cattle we added a correction factor to the population estimate. A review of ungulate aerial surveys indicated that up to 50% of the animals could be missed during the counts (Caughley 1974, Cook and Jacobson 1979, Caughley and Grice 1982, Gasaway *et. al.* 1986, Pollock and Kendall 1987). Therefore, an additional 50% of the cattle counted during the survey as added to the minimum count to produce an estimated population range.

### *Pigs & Goats*

I estimated pig and goat population sizes for Pagan based on density estimates for each species from the island of Sarigan. I utilized this method because the density estimates from Sarigan were based on the number of animals removed during the eradication program, which represents a total count for the island. In addition, habitat types and availability on Pagan were similar to those available on Sarigan prior to the eradication. Using the year 2005 C-CAP land cover maps for the Marianas provided by National Oceanic and Atmospheric Administration (NOAA), shows that Pagan has roughly 50% forested, 13% grassland, and 37% bare and Sarigan has 55% forested, 16 % grassland, and 29% bare.

Alternative survey techniques like line transects and aerial surveys were not considered feasible due to logistical constraints (i.e., limited time on island and rough terrain) and limitations of each survey method. One of the assumptions of the line transect method for estimating densities is that the animals do not move prior to detection (Buckland *et al.* 2001). Pigs and goats are known to move away from the observer which would bias the density estimates derived from this method. Pigs and goats were also believed to be primarily in the forested areas of the island which would limit the effectiveness of aerial surveys (see cattle above).

### *Pigs (Sus scrofa)*

As noted above, no specific survey was conducted for pigs. The extent of pig range and habitat use on the island was noted through field observation. The pig population was estimated using the pigs per hectare (ha) obtained from Sarigan island at 0.5 pigs/ha (Kessler 2002). The available pig habitat on Pagan was estimated at 2,360 ha, the area of the island considered forested based on NOAA land cover estimates. Available habitat was multiplied by the pigs per ha to arrive at an island estimate. The number of pigs on the island is expected to vary based on conditions on the island (e.g., drought years vs. heavy rain years). Therefore, I added and subtracted 30% of the population total to give future island managers a potential population

range to work with that included the best and worst years. This number is based solely on expert opinion and intended only to show a possible range that managers could expect to be working with.

### *Goats (Capra hircus)*

No specific survey was conducted for goats. The extent of goat range and habitat use on the island was noted through field observation. The goat population was calculated using the goats per hectare (ha) obtained from Sarigan island at 2 goats/ha (Kessler 2002). The available habitat on Pagan was estimated at half the islands total of 4,723 ha, the area of the island considered forested based on NOAA land cover estimates. Available habitat was multiplied by the goats per ha to arrive at an island estimate. Additionally, cows exclude goats from the habitat due to the ability of cows to have a higher browse line and thus limit forage opportunities for goats. Although this is not strictly true, (goats will cohabit with cows) it was observed that less goats were in areas utilized by cattle. In terms of agricultural livestock units one cow equals five to six goats (USDA 2007, NRCS no date). For this estimate six goats was used and subtracted for each cow observed. As for pigs above, 30% of the population total was added and subtracted from the population estimate to provide a range of population sizes for future managers. This number is based solely on expert opinion and intended only to show a possible range that managers could expect to be working with.

## **Results**

### *Cattle*

A total of 260 cattle were counted. If a maximum error estimation of 50% (i.e., 130 cattle) is applied then there could be between 260-390 cattle on Pagan. Cattle were found to only occupy the area of the isthmus and to the north and were not yet present in the southern part of the island (Figure 1).

### *Pigs*

Available habitat is estimated at 2,360 ha. If we assume that there are 0.5pigs/ha then there are estimated to be 1,180 pigs on Pagan. If a 30% error is factored the result is a population of feral pigs on Pagan Island of between 826 – 1,534 animals. Pigs were observed throughout Pagan Island from the north to the south.

### *Goats*

Available habitat is estimated at 2,360 ha. If we assume that there are 2 goats/ha then there are estimated to be 4,720 goats on Pagan. When cattle are factored in as using suitable goat habitat (1 cow = 6 goats) then 260 head of cattle multiplied by 6 goats per cow equals 1,560 goats that would be excluded by cattle. The estimated population of 4,720 goats would then be reduced by 1,560 to obtain an average of 3,160 goats on Pagan. If an estimated 30% error is factored, the

result is a population of feral goats on Pagan Island of between 2,212 – 4,108 animals. Goats were found throughout Pagan Island from the north to the south.

## Discussion

All habitats on Pagan Island were found to be severely impacted by feral animals. The island is generally in an overgrazed condition with prominent browse lines and extensive soil disturbance observed. Some small areas on the south end have escaped the full impact of the feral animals due to terrain, but still show at least some effect from goats and/or pigs. Cattle have yet to penetrate the swordgrass (*Mithicanus floridulus*) barrier that separates the south volcano from the isthmus (Figures 1 & 2), this has spared the south end the full brunt of all three ungulate species. However, cattle continue to graze on the swordgrass barrier and it is suspected that they will eventually eat their way through to the south end. Pigs and goats are present throughout the entire island. The isthmus and central part of the island including the airstrip, village, and lakes appear to be the most favorable areas for feral animals to thrive and show the greatest habitat destruction. Additionally on the east side beach is a fresh water seep that causes the cattle and pigs to go out on the coral reef during low tide. This is a unique situation of feral ungulates directly impacting a reef instead of the more usual indirect impact from siltation from soil erosion due to overgrazing.

Visual impacts of overgrazing are many. Large areas of open grass fields are encountered with available forage cropped to within an inch of the ground. Forests have no understory and show very little recruitment of new trees (Pratt 2010). For example, understory openness rankings at bird survey stations on Pagan, were higher than Sarigan and Asuncion where no ungulate populations exist (Figure 5). Eventually this suppression of new trees will result in less forest as trees age and die and are not replaced. As forest cover decreases, the amount of solar radiation reaching the forest floor increases and results in the drying out of the soil. This further prohibits native flora from growing or repopulating. Eventually grasslands expand into these open areas and are colonized by invasive species that ungulates find unpalatable. This last scenario is already being observed on Pagan around the airstrip and on parts of the isthmus where the invasive plants *Chromolaena odorata* and *Jatropha gossypifolia* are well established (Figure 3 & 4). This overgrazing is also restricting the colonization of ash covered areas by native pioneer species such as noni (*Morinda citrifolia*) and instead allowing ironwood (*Casurina equisetifolia*) to form a monoculture on the island's north end in the vicinity of the volcano impact area. Ironwoods are allelopathic and exclude other species through biochemical means, thus are characterized by a complete lack of understory. This makes these stands unusable for both native and feral species. An additional impact of the feral pigs is that they feed directly on coconut crabs (*Birgus latro*) which are a major natural resource to anyone on the island. These crabs are not only excellent fare, but serve to aerate and mix the soil and dispose of decaying material. Feral pigs are also suspected of feeding on endangered megapode (*Megapodius*

*laperouse*) and sea turtle eggs (*Eretmochelys* & *Chelonia spp.*) both of which lay their eggs in the soil making them very accessible to rooting pigs.

The over-grazed condition of the landscape is also reflected in the poor condition of the feral ungulates. Most ungulates appear in a semi-emaciated state, and although appear otherwise healthy, they show protruding hip and rib bones and little subcutaneous fat upon necropsy. Undoubtedly the browsing and grazing competition from the cattle limits the abundance of goats in areas of high cattle concentrations. Population numbers of all ungulates probably fluctuate widely due to drought or other environmental conditions. The cattle and pigs rely heavily on the two lakes, seeps, and any other sources of available water. This is because females that are lactating need a supply of fresh water. During the dry seasons there is probably a general migration of cattle and pigs to areas of water, which in turn increases the grazing pressure on these wetland areas. This lack of water and forage undoubtedly contributes to periodic die backs of cattle and pigs. During times of rain, anything from a coconut shell to a bomb crater will collect fresh water and allow expansion of grazing ranges. In the coconut forest areas there are thousands of coconut half shell to collect water and this in turn allows the cattle and pigs to meet their water needs closer to fresh grazing areas. Goats not needing a readily available source of fresh water are probably not unduly impacted by these events.

Although only calculated estimates are given for pigs and goats numbers, what is probably more useful to land managers is the estimated cost per hectare for eradication. Based on the Sarigan project, which is now ten years old, and the increase in distance of Pagan from Saipan, which will double logistical costs, it is estimated that the removal of feral ungulates will cost from \$800 to \$1500 per ha or between \$4,000,000 to \$7,000,000 for the island. For eradication it is suggested that the pigs and goats are removed first because the cattle will help keep the terrain open. Some consideration should also be given to either live capture of the cattle or the salvaging of meat for distribution, through the Northern Islands Mayor's Office, for good public relations.

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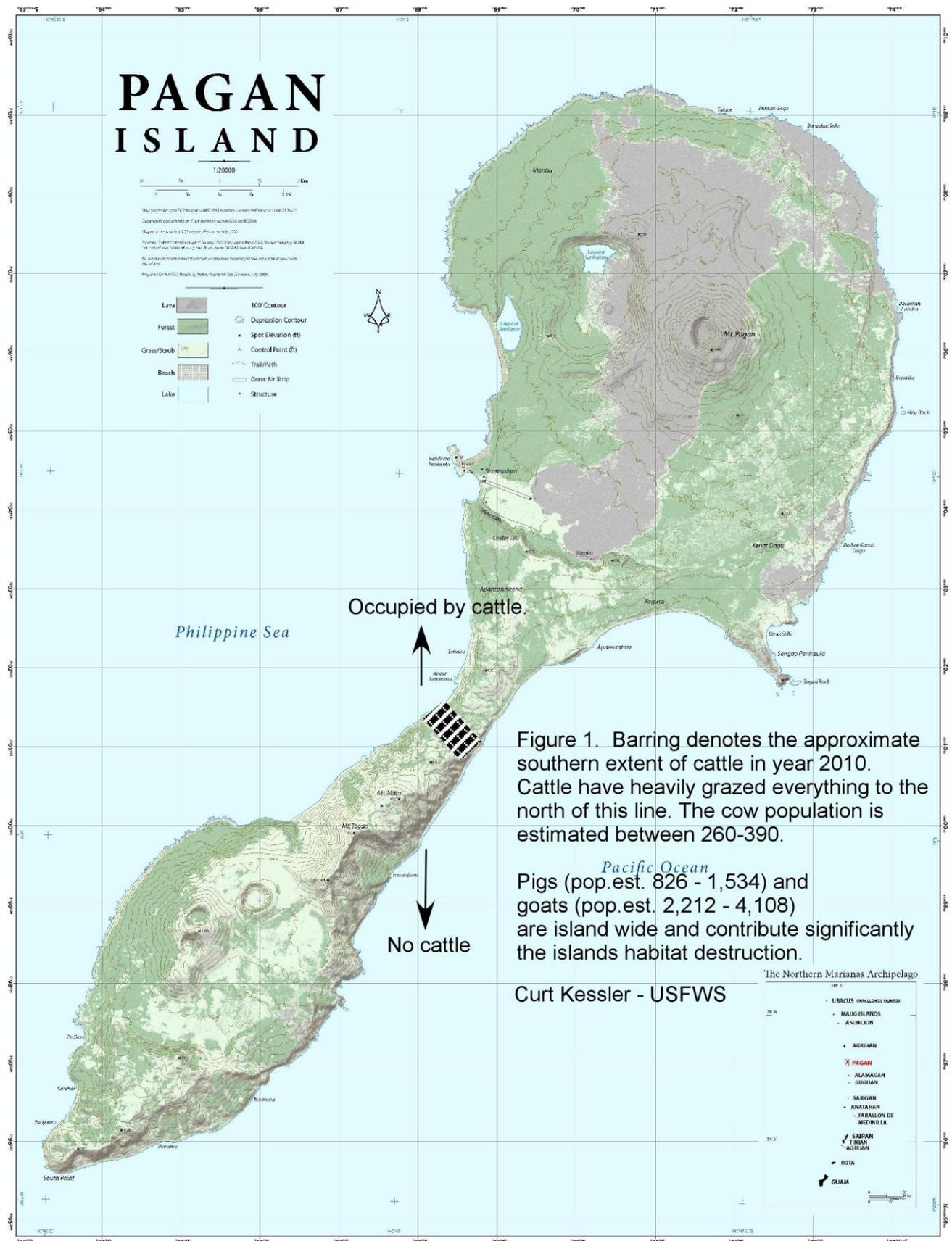


Figure 1. Barring denotes the approximate southern extent of cattle in year 2010. Cattle have heavily grazed everything to the north of this line. The cow population is estimated between 260-390.

Pigs (pop. est. 826 - 1,534) and goats (pop. est. 2,212 - 4,108) are island wide and contribute significantly the islands habitat destruction.

Curt Kessler - USFWS

Figure 2. South end of Pagan Isthmus. Barring shows the southern limit of cattle range. Cattle are slowly, but surely, eating their way to the south end. Foreground of insert (below) shows cropped swordgrass along cow trail. Only invasive plants, unpalatable to ungulates, thrive in this over grazed landscape. Cattle are relentless in pushing south to better pastures. C.C.Kessler 2009



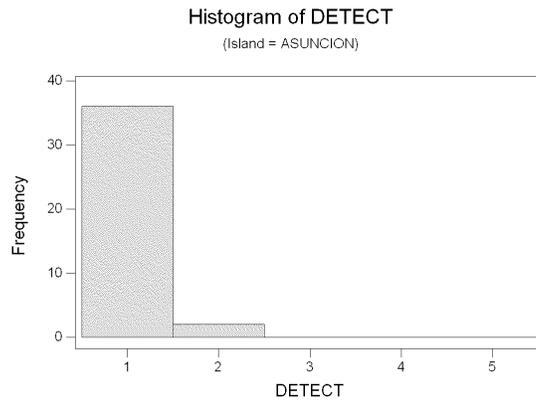
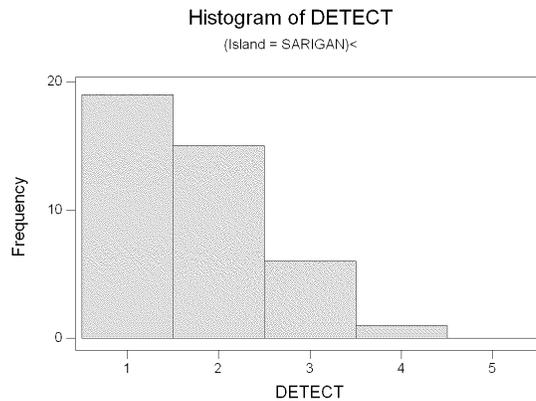
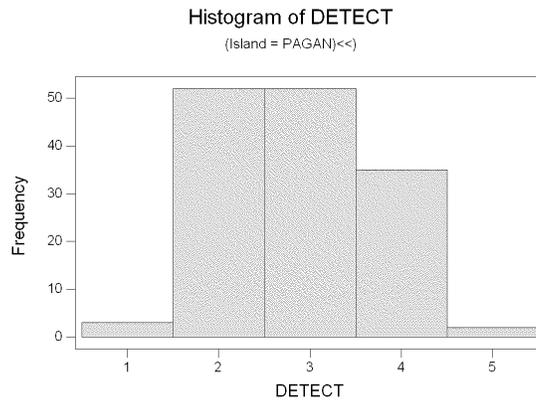


**Figure 3.** Invasive species *Chromolaena odorata* that readily colonizes disturbed and over grazed areas. This plant forms a monoculture that excludes native species. This patch covered much of the northern end of the Isthmus area. Active management is needed to curb this species. C.C.Kessler 2009



**Figure 4.** *Jatropha gossypifolia* is unpalatable to ungulates and thrives in disturbed areas. Here it is observed colonizing the heavily grazed grass fields near the air strip. It will eventually form a monoculture. C.C.Kessler 2009.





**Figure 5.** Frequency of bird survey stations by detectability code for the islands of Pagan, Sarigan, and Asuncion. All survey stations were in forested habitats and were surveyed in 2010. Detectability (DETECT) codes are defined as: 1 = visibility of 15 m or less, 2 = visibility averages 15 to 50 m, 3 = visibility over 50 m in 5-20% of area around station, 4 = visibility over 50 m in 20-50% of area around station, and 5 = visibility over 50 m in over 50% of the area around the station.