The Removal of Feral Cats from San Nicolas Island, California, to Protect Native and Endemic Species: 2010 Annual Report

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Annual Report – FINAL

January 2011

Suggested Citation:

Hanson, C.C., and Bonham, J.E., 2010. The removal of feral cats from San Nicolas Island, California, to Protect Native and Endemic Species: 2010 Annual Report. Unpublished report, Island Conservation, Santa Cruz, CA. 21 pp.

EXECUTIVE SUMMARY

Island Conservation, funded by the Montrose Settlements Restoration Program, began conducting a seabird restoration project on San Nicolas Island in 2009. The restoration project continued through 2010 in an effort to counter the negative impacts of feral cats on marine birds and other native wildlife through the removal of invasive feral cats. In coordination with the U.S. Navy, the U.S. Fish and Wildlife Service, the Institute for Wildlife Studies and The Humane Society of the United States, Island Conservation (IC) removed two feral cats from San Nicolas Island in 2010. These individuals were the last feral cats known to exist on the island. A total of fifty-nine feral cats have been removed to date. Of these, fifty-two adult cats were transferred to The Humane Society of the United States, where they are housed and cared for in an outdoor facility in Ramona, California.

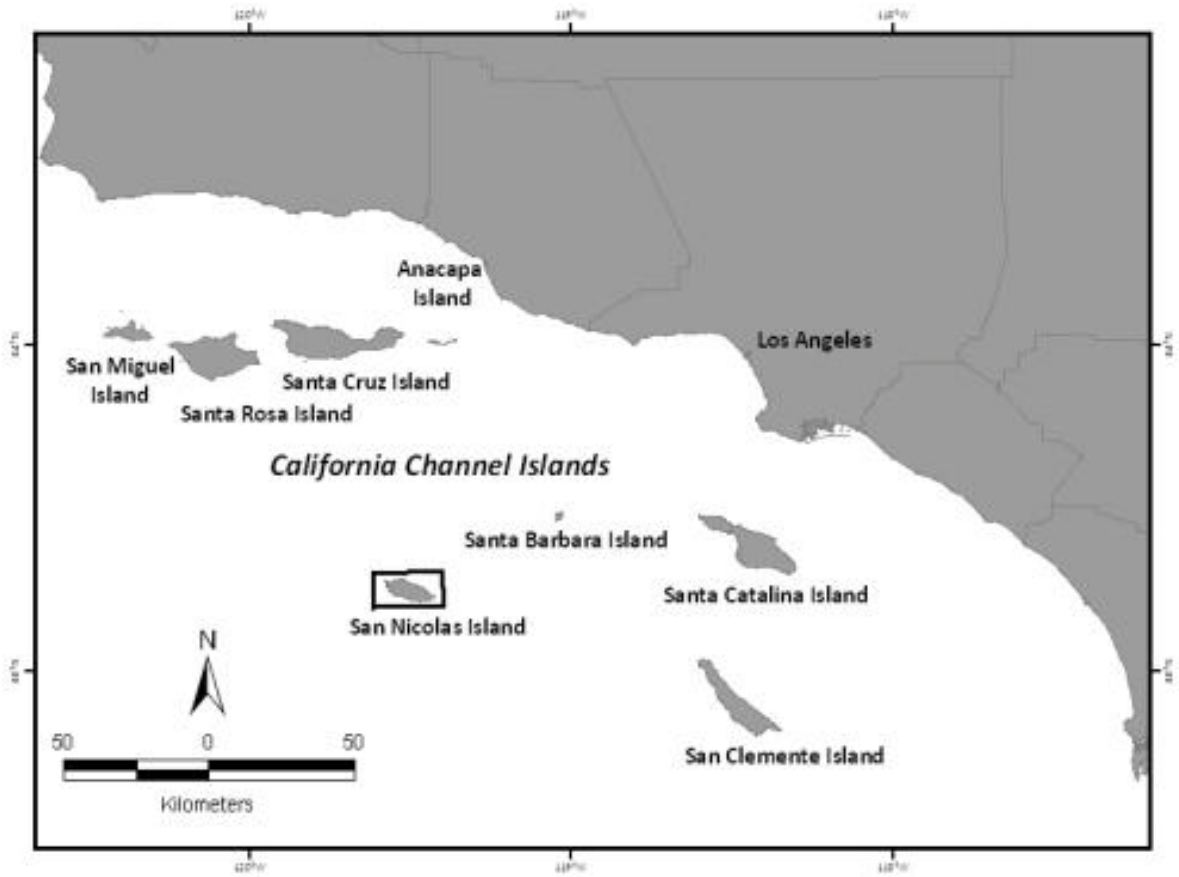
Several removal methods from 2009 continued into 2010, including the use of modified padded leg-hold live traps (through February 2010). Spotlight hunting was used to successfully remove the last two feral cats. The pupping season of the endemic San Nicolas Island fox, restricted access to parts of the island due to security, marine mammal presence on the beaches, and sea- and shorebird nesting and roosting continued to influence the methods and timing of removal efforts. Due to the presence of the abundant endemic island fox (>600 individuals (Garcelon and Hudgens 2008)), every effort was taken to reduce the risk of unintentional trapping injuries, including the decision to forego opening traps once all known feral cats were removed from the island. In total, there were 55 fox captures in 2010 with an injury rate of less than 6% (3 individuals). All injuries in 2010 were minor and required little, if any, intervention.

In December 2009, IC field staff deployed camera traps across the island to detect any remaining feral cats. By July 2010, a network of fifty-four cameras had been deployed with a camera placement plan in action to provide strategic coverage of the entire island. This action was in response to current best practices as well as in line with achieving results determined by a detection probability analysis. The detection probability analysis was conducted by Landcare Research, New Zealand to evaluate collected data and determine the likelihood that if a single

feral cat were on island it could be detected. The model suggested that to confirm complete removal, 427-1,200 camera nights or 55-75 km of sign searching should occur. By December 31, 2010, a total of 9,679 camera trap nights and 222 km of sign search had occurred since the last known feral cat was removed, with no feral cat detections. Based on information collected, efforts put towards detection, and the likelihood of detecting a feral cat had one been present, San Nicolas Island is considered to be free of feral cats although camera surveillance will continue through fall 2011.

INTRODUCTION

Figure 1. The California Channel Islands and San Nicolas Island.



U.S. Navy-owned San Nicolas Island is one of the Channel Islands located off the southern California coast (Figure 1). Feral cats on San Nicolas Island (SNI) are known to

depredate birds, both marine and terrestrial, including Brandt's Cormorants (*Phalacrocorax penicillatus*) and Western Gulls (*Larus occidentalis*), as well as the federally-listed threatened Island Night Lizard (*Xantusia riversiana*) and the island endemic Deer Mouse (*Peromyscus maniculatus exterus*) (Kovach and Dow 1981, McChesney 1997). In addition, feral cats are likely competitors with the state-listed threatened island endemic San Nicolas Island fox (*Urocyon littoralis dickeyi*) (Kovach and Dow 1981). SNI supports the largest population of island fox of any of the Channel Islands, with >600 individuals (Garcelon and Hudgens 2008). Fortunately, safe techniques to remove feral cats from islands have been developed, making the removal of feral cats from islands possible (Campbell *et al.* 2011). The removal of introduced species, such as feral cats, has become a widely accepted method for restoring island ecosystems. The goal of the project is to restore seabird populations and ecosystem function on SNI by removing feral cats.

The SNI restoration project is currently ongoing. This report presents activities from January 1, 2010 through December 31, 2010. The preferred alternative for removing feral cats from SNI was identified in the Final Environmental Assessment (EA; USFWS 2009) and included an adaptive management approach using live trapping and hunting. Effort exerted in 2009 resulted in the removal of the major population of feral cats existing on SNI (Hanson *et al.* 2010a). One feral cat was known to remain on island as the campaign continued into 2010 (Hanson *et al.* 2010b). Methods of removal were continually being assessed for efficacy, as well as reviewed to ensure all actions remained in line with best practices.

METHODS

Island Preparation

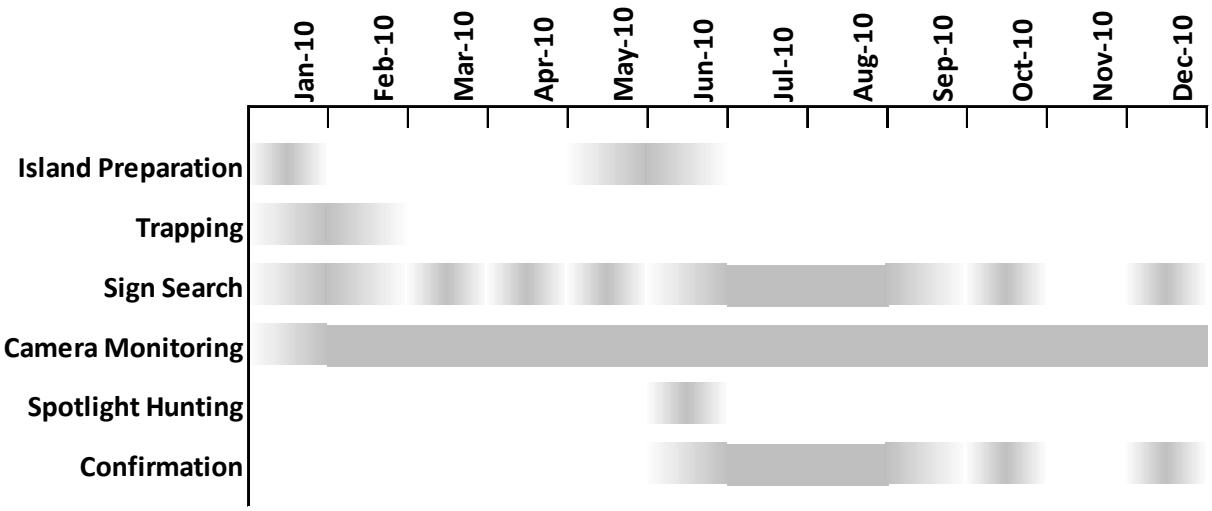
Facilities

On January 26, 2010, all traps and trap monitors were deactivated and removed from the field. At this point, staff living quarters and shop facilities were prepared for a temporary closure that coincided with the island fox pupping/rearing season (March 1 – June 30). Two staff returned for ten days in February to utilize the remainder of a seasonal trapping window during an unexpected span of favorable weather conditions. Efforts to monitor camera traps and initiate spotlight hunting developed into three additional short trips that occurred between March and

June 2010. These trips allowed for the inspection and brief utilization of all facilities reserved for IC use.

Upon the return of a full-time presence on island in mid-June, both building 187 and the staff living quarters were reoccupied on a full-time basis until September 2, 2010. In response to the status of the project, full-time occupation of these facilities is not expected to occur prior to the project's completion. Brief eight day trips to assess and collect camera trap data occur on regular intervals every 2-3 months and are expected to continue until the fourth quarter of 2011. Equipment and supplies have suffered from leaving buildings vacant. Infrequent visits, coupled with an inability to seal off the premises, have allowed rodents and birds to reclaim the buildings. As a result, any preparation and/or consumption of meals within those buildings are no longer carried out due to health risks. A more flexible field schedule is allowing the use of Nic-town restaurants during camera trap monitoring trips.

Figure 2. Time sequence of activities on SNI for feral cat removal and monitoring.



Trail Restoration

During the winter of 2009 and spring of 2010, San Nicolas Island experienced heavy rainfall events on two separate occasions. As a result, flooding and erosion had a direct impact on trail access around the island. Heavy flows of water mixed with sediment degraded trails and carved out new ravines, resulting in a number of impassable features along areas of the southern

and western zones. Before departing SNI in January 2010, IC field staff identified damaged trail locations and assessed the time needed to repair each site prior to returning to the island later in the year.

Figure 3. IC staff member providing scale for new erosion that bisects the zone 6 access trail.

In June 2010, IC staff returned to a full-time presence on island in preparation for trapping. Trail restoration began immediately and was comprised of roughly 2-3 weeks of intermittent work. During the restoration of trails, the original procedures were followed concerning cultural resource awareness and environmental considerations. As described in the Final Environmental Assessment (EA; USFWS 2009), IC followed the established erosion mitigation measures and continued to monitor for any changes in the environment caused by human/vehicle presence. Chain link netting used for track stabilization was reassessed for condition and additional netting was anchored on steep, soft banks where needed to prevent vehicles from destroying trails. Additional culverts were not needed as current culverts remained intact and functional. Navy Natural Resources staff had the opportunity to travel on the temporary trails after they were finished as all roads were safely accessible by both motorcycle and UTV (Utility Terrain Vehicle). IC field staff continued to provide periodic updates about trail conditions over the course of 2010.

Vehicles

Project operations utilized two trucks, three motorcycles, and three UTV's to access the island until the initial demobilization of gear, which occurred on September 2, 2010. After a delay of four weeks, one truck, one UTV, three motorcycles, and an enclosed utility trailer were removed from the island on the Navy contracted barge. Per Navy regulation, all IC field staff remained certified to operate each piece of equipment. Certifications included an off-road motorcycle safety course, an ATV safety course and a valid motorcycle endorsement on their valid class C driver's license. Both trucks and UTVs remained the primary mode of transportation. Motorcycles were only used during dry conditions due to safety considerations. Vehicles were pressure washed as needed to minimize risk of spreading weedy plant species.

Trapping (padded leg-hold live traps)

A limited number of traps were utilized for a brief period from January through February of 2010. These traps were targeted at an individual cat that was detected during a camera trapping trial (see Trapping (camera) below). Due to rainy weather conditions, trap sets were often degraded to a point where they were no longer effective for targeting feral cats. It was determined by managers that risk to foxes was not warranted if the efficacy of traps was negligible. Trapping was not permitted from March 1 – June 30 due to the island fox pupping/rearing season. Actions were taken to prepare SNI for traps to be activated on July 1, 2010. Due to all detected feral cats having been removed prior to July 1, 2010, traps were not opened to prevent unnecessary risk of injury to foxes. Traps remain an option to remove feral cats if detection is made prior to removal confirmation.

Trapping (camera)

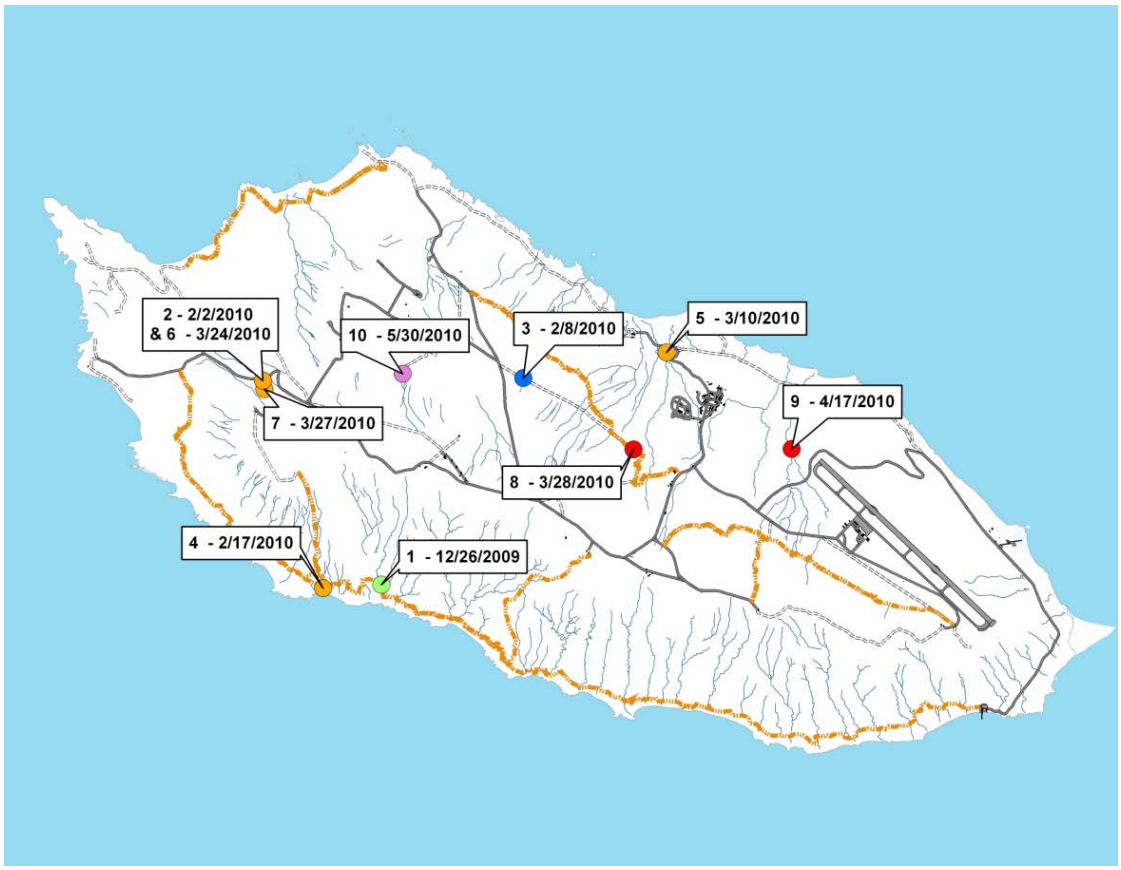
Preparation

Initial trail cameras purchased for trial on SNI were ineffective and unreliable during a trial process. Demanding island and monitoring conditions required managers to utilize Reconyx professional series cameras. A month long field trial of two Reconyx trail cameras was conducted between December 2009 and January 2010. Results collected suggested that battery life, memory capacity, and reliability in the field were satisfactory. One feral cat was detected during this trial, further expressing the need for a functioning network of camera traps on island. The time required to source an adequate camera model delayed placement of a network of

cameras across the island until late January 2010. On January 25, 2010, a network of twenty-six Reconyx camera traps was deployed over the island where feral cat activity had been recorded or would be suspected to occur, if present.

Over the course of four trips allowing for cameras to be downloaded, 10 feral cat photo capture events occurred prior to June 2010 (Figure 4). All photos captured were of the same individual; a large orange tabby tomcat with a kink in its tail. Capture events of this one individual had occurred over 4 months across more than half the island. This behavior suggested to managers that the individual was in search of con-specifics, as the average home-range of a male feral cat in the Channel Islands was 2.6 +/- .4 km2 (Guttilla 2007).

Figure 4. Feral cat photo captures (circles) between December 2009 – May 2010.



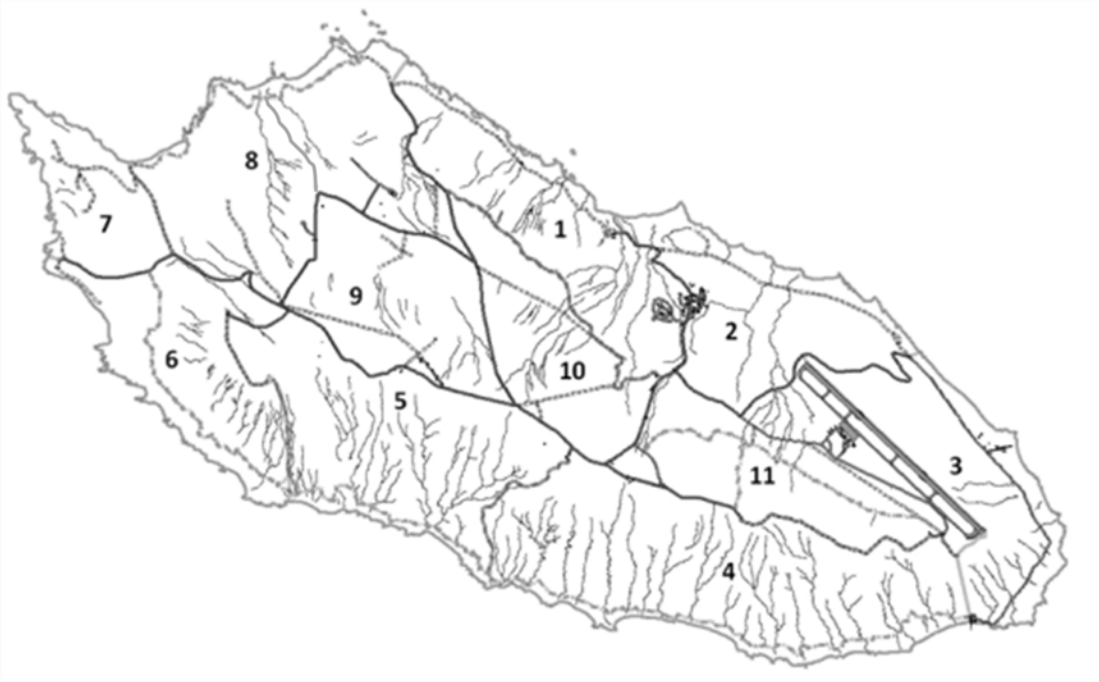
Twelve cameras were purchased and added to the network over June 18 – 26 2010. The additional cameras improved the frequency at which detections were made as well as reduced gaps in coverage. As a result, one additional female feral cat taking refuge within an apparently

small home-range was exposed. This detection occurred to the North of photo location #10, half of the distance to the coastline (Figure 4). Spotlighting efforts were guided by most-recent camera detections. After all known feral cats were removed, a subsequent purchase of 16 additional cameras enhanced the network coverage, aiding confirmation. These cameras were placed on island between June 26 and July 3, 2010. The decision to purchase a total of fifty-four cameras was guided by the detection probability model produced by Landcare Research, New Zealand. Based on results acquired throughout the project, the model suggested cameras were the most significant tool available for detection. The number of cameras directly influenced the duration of monitoring necessary. This was due to an increased rate at which staff would achieve removal success with 99% confidence.

Military Closures

Military closures continued to occur on SNI throughout 2010. Access was restricted to large areas of terrain, though interruptions to project activities were minimal due to a reduced dependence on trapping. Project staff maintained the use of the previously determined 11 zones, which were based on geographic features, roads and access points (Figure 5). When closures occurred, any active traps within the affected area were de-activated to prevent captures and reopened once the operation was complete. Operational closures due to the Navy's range activities varied in length from a single day to several weeks.

Figure 5. Map of San Nicolas Island showing work zones, roads, drainages and ATV trails.



Trap Monitoring System

Trap monitors remained in the field over the 2009/2010 winter trapping season. Protocol continued to require routine maintenance inspections of non-responsive monitors and monitors that had not been visually inspected within five days (Will *et al.* 2010). Monitors that failed to report back with a signal were responded to immediately and inspected for antenna disruptions, water damage and battery life. New batteries would be installed and if any signs of water permeation existed the entire monitor would be replaced. Antennas that had fallen off of their mounts were returned and re-secured. Twenty-two monitors experienced water damage and were replaced. Upon the demobilization in February, all monitors were removed from the field, inspected/cleaned, had batteries removed, and stored for future use.

Data Collection System

Archer field computers were utilized to capture data throughout 2009 and continued to remain a critical resource in 2010. Emphasis was directed towards logging accurate sign search track-logs, key feral cat habitat, and camera sites. Customized drop-down menus evolved as new protocols were instated and specific data was required by the detection probability model. Along

with new fields, previously standardized data entry options remained; each item requiring field staff to choose from preset options. The database and ArcPad interface took the place of paper forms and streamlined the process of gathering information in the field and processing at the end of each day. Captured information about trap and camera checks allowed IC field staff to manage scheduling of regular maintenance and relocation of traps/cameras that included a visual inspection of each trap/camera site as the protocols directed.

Spotlight Hunting

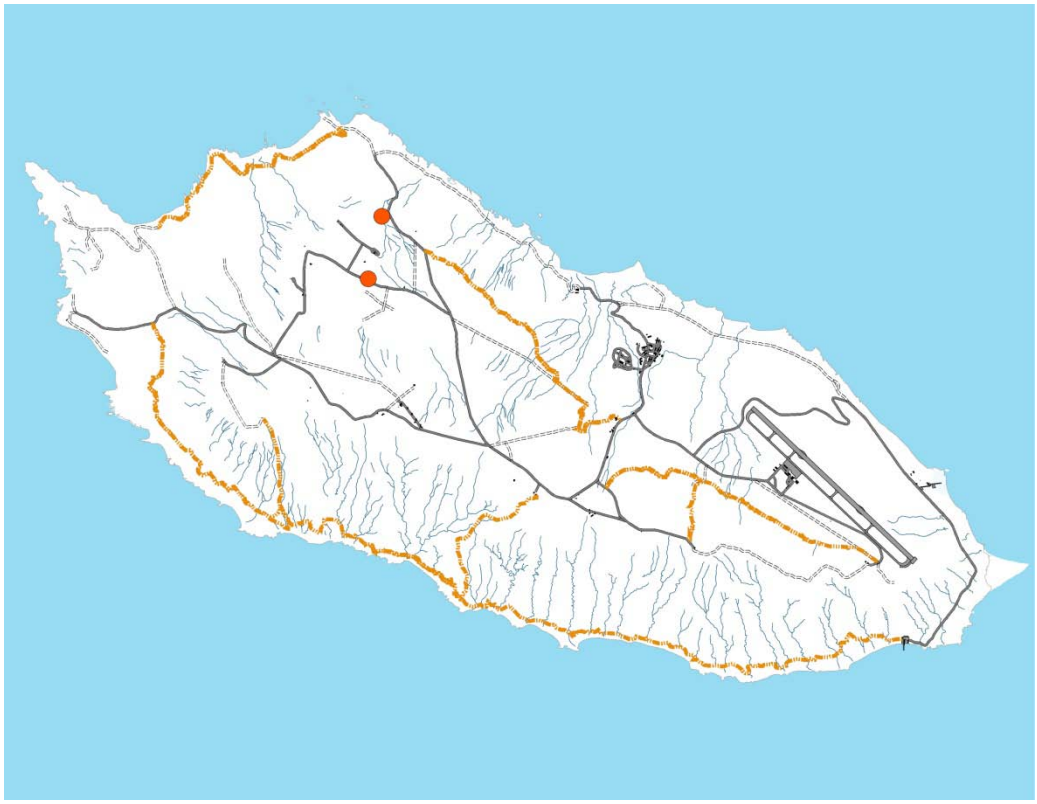
Spotlight hunting was utilized in June 2010 once the second cat was detected and also to reduce risk to foxes from the use of traps. A team of two IC staff with the assistance of an Institute of Wildlife Services (IWS) employee initiated spotlighting on June 1 and continued nightly through June 6. Two incidents involving possible sightings occurred in zone 9 on separate occasions; because the species of animal detected could not be confirmed, no shots were taken. A later campaign taking place June 21 – 26 utilized an IC shooter. Alterations to the shooters position were made by relocating from inside the cab of the truck to the cargo bed. Searching techniques remained the same comprising of one truck with staff operating spotlights on either side. All zones received coverage, as the vehicle was driven at or below 10 miles an hour down safely accessible roads. Staff would search terrain for movement or 'eye shine'. Upon the detection of eye shine staff members would confer to confirm species; feral cat or fox. Only in the event that all staff agreed that a detected animal was a feral cat would the shot be taken. This process complied with environmental assessment guidelines set prior to the project implementation.

Conditions varied nightly and by location, including clear skies, heavy dense fog, wind, and light precipitation. Each night, an average of 33.6 km of roadway was searched comprising 17.4 man-hours of spotlight work. Areas where feral cats had most recently been detected by cameras were focused on as a priority, with densely vegetated areas (within which spotlighting is ineffective) receiving less attention. On the night of June 25, 2010, eye shine was detected, confirmed as a feral cat, and dispatched on-site. The individual was recovered and positively matched to archived photos of one of two feral cats remaining on island. The following night, staff targeted a drainage suspected to be occupied by the remaining feral cat. The head of the drainage, which was not visible from the vehicle, was searched on foot. No detection was made

and staff returned to continue the search from the vehicle platform. Upon entering the mouth of the drainage, eye shine was detected across the ravine. Confirmation that it was a feral cat was made. The individual was dispatched on-site. The retrieved animal positively matched photos of the remaining feral cat known to exist on island. Both animals were delivered to IWS staff for necropsy.

In response to no known feral cats remaining on island, spotlighting was discontinued after the night of June 26, 2010. This decision allowed camera traps to continue as the primary detection tool and preserve spotlight shooting as a subjective removal method.

Figure 6. Location of feral cat removals in 2010 (shown as red circles)



Sign Search

Sign such as prints, scat, latrines, scratch posts and predated seabird carcasses were used during the course of the project to detect the presence of feral cats. Sign searching by IC field staff occurred both in structured transects across zones, as well as in spot treatments informed by GIS data queries. IC field staff logged feral cat sign locations into the Archer handheld

computers, allowing for the island-wide mapping of feral cat sign. Probable home range areas for feral cats on SNI were identified based on home range estimates from a detailed study of feral cat home ranges on Santa Catalina Island by Guttilla (2007) and feral cat sign density from SNI. Staff activity and sign search efforts were heavily influenced by these spatial analyses as well as GIS data showing optimal habitat types/features. In addition, personnel track logs were routinely monitored by managers to direct search activity to areas that appeared as gaps in coverage.

Weather and substrate conditions continued to affect sign search results and confidence of search results. Efforts were made to take advantage of calm days and weather conditions that would deliver optimal tracking conditions. The greatest factor affecting sign search was the large number of fox tracks, wind, and poor tracking substrate. Discerning feral cat from fox tracks is particularly difficult, though a number of key features allow staff to make the best estimate of species type. Tracks of questionable origin would be analyzed by multiple staff. Search fatigue is a continual concern, especially when searching areas with high fox activity levels. As a result, staff was rotated to new zones on a routine basis and field visits were reduced in duration.

Camera Monitoring

After removal of the last two known feral cats, an organized and structured camera management program was implemented to detect any remaining individuals and progress towards confirmation of complete removal. Priority areas were identified through evaluation of previously collected data and a GIS assessment of habitat types similar to that which harbored the last removed individuals. These areas were considered the most likely to hold remnant individuals. By July 8, 2010, cameras had been placed in the last designated priority areas and 763 camera trap nights had been conducted. No feral cats were detected during the priority area monitoring.

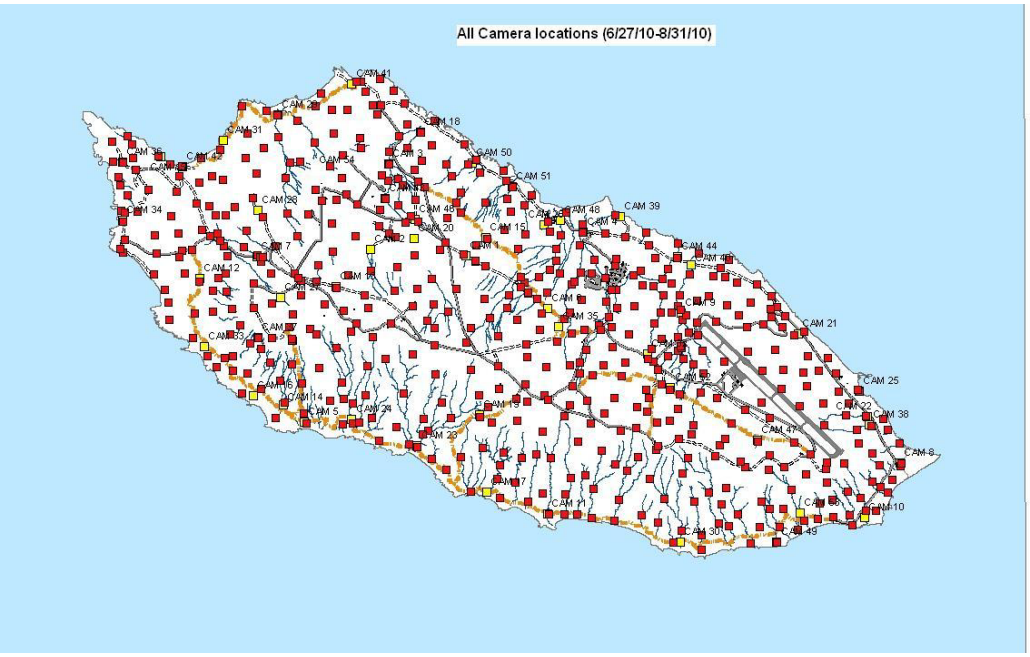
Monitoring of the priority areas was followed by a second systematic monitoring effort of the entire island. The second phase was initiated on July 9, 2010. This phase ensured remaining habitat types and any perceived gaps in camera coverage were included, progressing towards final confirmation. For the second phase the camera inventory was divided into two groups, with each managed under different schedules. The first group consisted of nine cameras designated to

cover key locations. Key locations were defined as sites where feral cats had been previously removed, large amounts of feral cat sign had been found during the trapping campaign, or multiple pictures of the last remaining feral cats had been recorded. Cameras deployed at key locations were revisited every 7 days to replace the memory card and were relocated every 14 days.

The second group consisted of 45 cameras designated to cover home ranges. Home range cameras were deployed in a grid-like fashion to facilitate a thorough monitoring program. Five hundred meter spacing was chosen to facilitate a minimum of one camera location in every potential home range, using home range sizes documented on Catalina Island, California as reference (Guttilla 2007, Guttilla and Stapp 2010). The general rule for camera spacing in drainage areas was a minimum of 1 camera every 500m, with the option for higher camera densities. In low quality habitat the minimum spacing was 1 camera every ~500m. Locally, cameras were placed in areas that provided the best available field of view, maximizing the cameras coverage potential. Specific placement within the habitat was determined by field staff based on their knowledge of feral cat behavior (Figure 7).

The forty-five cameras were managed as a rolling front, continually progressing around the island. The cameras were moved on a five day rotation. Each day, one-fifth (9) of the 54 cameras were moved to new locations and deployed with a fresh memory card. On August 27, 2010 the second phase of camera monitoring was completed, and a total of 3,026 camera nights had occurred since the last known feral cat removal. The cameras were then placed in key locations to continue confirmation of complete removal, with personnel returning to service cameras every 2- 3 months.

Figure 7. Camera trap locations from June 27 – August 31, 2010. Yellow squares depict key camera sites on August31, 2010.



Return service tours began in October 2010, with two personnel able to service all fifty-four cameras in roughly eight days. Previous camera location data was analyzed at the beginning of each tour to determine areas that had not been previously monitored or had not been monitored for the greatest amount of time. These areas were given preference for camera relocation. In addition to relocating cameras, servicing of cameras included switching memory cards, checking battery life, and ensuring cameras were functioning properly. Personnel had the option to allow cameras to remain in locations for more than one tour length (2-3 months) based on their perceived need for additional monitoring in that area. The camera monitoring service tours are planned to continue until December 2010, marking two years of continued monitoring.

Detection Probability Model

IC contracted Landcare Research to develop a detection probability model to determine the probability of detecting a feral cat if one was present, as has been done for other removal projects (e.g., pigs; Ramsey *et al.* 2009). In addition to estimating the probability that no feral cats remain, the optimal amount of effort utilizing preferred methods was determined to provide the most cost effective and efficient means of confirming complete removal; a first for any

removal campaign. The model incorporated data collected throughout the project, projected cost estimates of methods and activities, and feedback obtained from expert opinion on the project's status.

Prior to the removal of the last two known feral cats on island, it was determined with 95% confidence that between one and four feral cats remained on island. There was a 60% chance that only one feral cat remained and an approximately 20% chance that two feral cats remained (Ramsey and Parkes 2010). After the second feral cat was detected, the report was revised to provide a guideline for passive monitoring. Guidelines were based on stopping rules that minimized two outcomes: wrongly declaring removal success and excess cost associated with monitoring after complete removal had been realized (net expected costs were balanced with costs associated by wrongly declaring removal complete). It was determined that once the last detected animal was removed, 55-75 km of sign search and 427-1,200 camera trap nights would be needed (without a detection being made) to provide a 99% confidence level that complete removal was achieved (Ramsey and Parkes 2010).

Methods used in post-2010 monitoring trips have been determined in consultation with the lead and cooperating agencies, Montrose Trustee Council, and other relevant stakeholders. Efforts made to confirm SNI free of feral cats exceeded Ramsey and Parks' recommendations by August of 2010.

Sightings on Island / Response:

Between November 18 and November 24, 2010, a sighting of an animal suspected to be a feral cat was reported by a Navy contractor visiting the island. This information was later relayed to Navy Environmental staff on December 4, 2010 and ultimately provided to IC staff on December 9, 2010 while on-island for a routine camera monitoring trip. While on island, staff efforts focused on the surrounding location where the sighting was reported to have occurred. Additional cameras were repositioned and sign search occurred in the vicinity of the report. No evidence of a feral cat was obtained from cameras positioned across the island or from sign search activities.

A follow-up questionnaire soliciting details about the sighting was provided to the witness on December 28, 2010. Details included the location, time of day, features about the

sighted animal, and degree of confidence that the sighting was a feral cat. Additional follow-up to clarify the eyewitness report occurred in January and March 2011. Analysis of the report suggests that an animal was sighted at night, though limited detail could be provided that described the subject distinctly. A return trip to monitor camera results in February 2011 did not produce any evidence that a feral cat remained on island.

RESULTS AND DISCUSSION

Between January 1 and December 31, 2010, 70 trap nights occurred with up to 11 active trap sets being open at any one time. Trapping was unsuccessful in capturing feral cats in 2010. Captures of the island fox totaled fifty-five over this timeframe. IC brought a total of six foxes to the IWS clinic, of which three (<6% of total) had treatable project-related injuries: possible dislocation of a metatarsal, laxity in the carpus joint, swelling in the capture leg. Of the remaining three foxes, two were determined not to have injuries or conditions related to the day they were trapped. One additional fox exhibited coughing at the trap site, though no abnormalities were found and the behavior did not occur again while in temporary holding at the fox clinic (Garcelon 2011, in prep). To our knowledge, no project related fox fatalities occurred in 2010.

As initially demonstrated in a trial study conducted in 2006, as well as results from trapping in 2009, foxes become more trap-averse due to visual and olfactory cues at the trap site (Island Conservation 2006, Hanson *et al.*, 2010b). It was noted that after removing our network of traps from the environment in December 2009, foxes were more prone to recapture once traps were replaced in early January 2010. Of fifty-five captures, thirty-eight were recaptured from 2009. It remained consistent that after seven days of a traps being opened, capture rates of foxes were dramatically lower. On average, foxes were caught 2 ± 1 times (N=1,012), with one individual being caught seven times. It still remains unclear if foxes were conditioned to avoid specific site locations or to avoid standardized sets in general.

The trap monitoring system allowed project staff to effectively and efficiently monitor all traps placed in the field. The system worked as expected with no monitor failures.

Spotlight hunting occurred during two trips consisting of twelve days in total. One hundred and ten hours of spotlight hunting took place. Two feral cats were removed in June 2010

through the use of spotlight hunting. The first removal was a large, reproductive male. The second and final individual removed was a reproductive female nearing the end of a pregnancy with two offspring in utero. Foxes were routinely spotted during each trip with an average of 6-10 animals being sighted per night.

Tissue samples were taken from the last two adult individuals removed and the two offspring in utero. Additionally, eight fecal samples were collected. Two were directly collected from the colon of the recently removed adult animals, while six were discovered during sign search activities in the field. Samples were sent to Wildlife Genetics International (British Columbia, Canada) for analysis. DNA was extracted from scat samples using QIAGEN's QIAamp Mini Stool kit, and from tissue samples with QIAGEN's DN easy kit. Species testing was performed on all scat samples (excluding those removed directly from feral cats) to confirm the samples were from a cat. Two of the samples produced mtDNA profiles similar to the reference profile from gray fox, leading to the conclusion that they were from Channel Island Fox. The remaining samples produced domestic cat profiles.

Tissue samples were analyzed at 11 felid microsatellite markers. This comprised of nine markers specific to domestic cats and two from other felid species. The genotyping process included a first pass using all 11 markers and 3 μl of DNA per reaction followed by a cleanup phase in which samples were re-analyzed using 5 μl of DNA per reaction. The 4 tissue samples all had high-confidence genotype scores for all 11 markers. Two of the eight scat samples were from Channel Island Fox, while the remaining six matched profiles of domestic cat. A multilocus analysis with a total of 11 felid markers was performed on samples to determine genetic identity. A wholesale repeat of the multilocus analysis was performed on both scat and tissue samples. Six of the cat scat samples failed the multilocus analysis, while the two samples extracted directly from the cats provided genotypes. All of the tissue samples performed well in the multilocus analysis and the lab was able to successfully match the scat samples to their respective tissue samples. After a paternity test on the tissue samples, the male and female were matched as parents of the kittens due to a high degree of heterozygosity found in the respective donors. However, without testing a greater portion of the island's population, the possibility remains that this could be a random match.

Thirty-eight trail set cameras were utilized to monitor SNI for feral cats prior to the removal of the two remaining animals. Eighteen positive feral cat detections were collected from December 2009 – June 26, 2010. Three sites provided multiple detections from separate dates while fifteen locations had only experienced a single detection event. By the end of 2010, 9,679 camera trap nights have taken place since June 26, 2010 with no sign of feral cat presence having been detected.

The last known feral cat removal occurred on June 26, 2010. Following that date, no feral cat sign or photo has been produced. All suspected feral cat sightings (only one occurred) were investigated and reviewed in conjunction with camera results. Until monitoring efforts provide additional evidence, the reported observation has been determined to be a mistaken report of an island fox.

RECOMMENDATIONS

It is recommended that the use of trail cameras should continue throughout the remainder of the project (confirmation phase). The detection of any new sign, including feral cats captured on cameras, would be responded to by trapping or with spotlight hunting until the detected individual is removed. The profile of each feral cat photographed, based on color, markings, and size, will be recorded and referenced to help determine the probability that any future animals removed match that profile. Genetic analysis may be used to profile individual remnant cats. DNA from cats captured can be compared with the scat and/or hair samples collected previously in the field. IC currently has a protocol and a genetics lab identified (Wildlife Genetics International) to work with.

Monitoring trips to SNI are scheduled to occur on a regular basis to examine camera activity and allow project staff to remain poised for immediate return in the event of a feral cat detection. Products necessary during monitoring trips:

- Inspection of Reconyx trail cameras including the downloading of photos and any readjustments necessary to provide optimal performance/results;
- Review, analysis, and cataloguing of photos obtained from trail cameras;
- Sign search in areas that are prioritized by the potential of feral cat occurrence;
- The repositioning of trail cameras to alternate locations, and;

- Collection and storage of sign (scat) for later DNA analysis (if found)

ACKNOWLEDGEMENTS

This campaign would not have been possible without the continued support of IWS staff. Advice from Bill Wood and Jeff Davis was highly valued as the project developed. Grace Smith, Annie Little, and David Garcelon provided continual support and feedback throughout this project. The removal of feral cats from SNI was funded by the Montrose Settlements Restoration Program and supported by the U.S. Navy and the U.S. Fish and Wildlife Service.

REFERENCES

Campbell, K. J., G. Harper, David Algar, C. C. Hanson, B. S. Keitt, and S. Robinson. 2011. An updated review of feral cat eradications on islands. Turning the Tide II. ISSG, Gland, Switzerland.

Garcelon, D. K., 2011. SNI 2010 Annual Report. In prep.

Garcelon, D.K. and B.R. Hudgens. 2008. Island fox monitoring and demography on San Nicolas Island 2007. Unpublished report prepared by the Institute for Wildlife Studies, Arcata, CA. 28pp.

Guttilla, D. A., and P. Stapp. 2010. Effect of sterilization on movement of feral cats at a wildland urban interface. Journal of Mammalogy, 91(2):482-489.

Guttilla, D.A. 2007. Effects of sterilization on movement, home range behavior and habitat use of feral cats on Santa Catalina Island, California. M.S. thesis. Department of Biological Science. California State Univer., Fullerton.

Hanson, C. C., K. J. Campbell, J. E. Bonham, and B. S. Keitt. 2010a. The removal of feral cats from San Nicolas Island: Methodology. Proc. Vertebr. Pest Conf. 24

Hanson, C.C., Will, D.J., Bonham, J.E., and B. S. Keitt. 2010b. The removal of feral cats from San Nicolas Island, California to Protect Native and Endemic Species: 2009 Annual Report. Unpublished report, Island Conservation, Santa Cruz, CA. 19 pp.

Island Conservation. 2006. Restoring seabird populations on San Nicolas Island: Testing techniques to remove feral cats. Island Conservation. Santa Cruz, California. 7 pp.

Kovach, S.D., and R.J. Dow. 1981. Ecology of the feral cat on San Nicolas Island. 1980. Pacific Missile Test Center, Point Mugu, California. 27 pp.

McChesney, G.J. 1997. Breeding biology of the Brandt's Cormorant on San Nicolas Island, California. M.S. thesis, California State Univ., Sacramento.

Ramsey, D. S. L., Parkes, J.. 2010. Quantifying the Success of Feral Cat Eradication on San Nicolas Island, California. Landcare Research New Zealand Contract Report. 34pp.

Ramsey, D.S.L., Parkes, J., Morrison, S.. 2009. Quantifying eradication success: The removal of feral pigs from Santa Cruz Island, California. Conservation Biology 23, 449-459.

USFWS. 2009. Final Environmental Assessment for the Restoration of San Nicolas Island's Seabirds and Protection of other Native Fauna by Removing Feral Cats. U.S. Fish and Wildlife Service, Carlsbad, CA. 105 pp.

Will, D. Hanson, C. Campbell, K. Garcelon, D. Keitt, B. 2010. A trap monitoring system to enhance efficiency of feral cat eradication and minimize adverse effects on non-target endemic species on San Nicolas Island. Proc. Vertebr. Pest Conf. 24