MSRP Seabird Restoration Program – San Nicolas Island, California

Annual Report on Island Fox Care and Monitoring Provided in Support of the San Nicolas Island Seabird Restoration Program– 2010

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INTRODUCTION

In 2009, the Montrose Settlements Restoration Program (MSRP), in cooperation with the U.S. Navy, initiated a project to protect seabirds and other native wildlife on San Nicolas Island (SNI) through the removal of feral cats (*Felis catus*). Feral cats kill millions of birds and small mammals each year (Warner 1985, ABC 2004), can severely impact island bird populations (Merton 1977, Moors and Atkinson 1984, Dowding and Murphy 2001) and have been responsible for the extinction of at least 33 bird species worldwide (Lever 1985). The removal of feral cats from SNI was initiated to help restore seabird populations, reduce impacts on native species such as the island night lizard (*Xantusia riversiana*) and reduce competition for resources with species such as the island fox (*Urocyon littoralis*) (USFWS 2009).

After release of the draft Environmental Impact Statement (USFWS 2008), the U.S. Fish and Wildlife Service and the U.S. Navy entered into dialog with animal protection groups regarding the feral cat removal project, including discussion regarding whether lethal removal would be used as the main removal method. The Institute for Wildlife Studies (IWS) was contracted by MSRP to work with the largest of the animal protection groups, the Humane Society of the United States (HSUS), in their effort to evaluate if using live-capture box traps would be an effective means of capturing the cats. HSUS staff visited the island to test out methods of live capturing feral cats using box traps and a variety of enticements. While numerous island foxes were captured, no feral cats were trapped. IWS continued testing methods suggested by HSUS for trapping cats in box traps over a 4-month period, and then compared that capture success with a brief capture effort using padded leg-hold traps (Garcelon 2009). Results from this investigation found that capture success for feral cats was significantly higher in leg-hold traps compared to box traps, suggesting that feral cats may be wary of entering box traps. Considering the much greater efficiency of using leg-hold traps to capture feral cats on SNI, and the fact that no cats were injured during the leg-hold trap testing, that method was adopted for conducting the bulk of the subsequent feral cat removal effort.

Trapping effort began in June 2009 by Island Conservation (IC), the organization contracted to conduct the removal of the feral cats. IWS was contracted to provide support for the project by caring for any foxes that might become injured in traps during the project, and to evaluate impacts of the leg-hold trapping effort on the fox population overall. After it was later determined that all cats that could be captured would be transported live to an HSUS holding facility, IWS also was tasked with caring for the cats until they could be transferred off of the island (Garcelon 2010).

The large majority of the leg-hold trapping component of the feral cat removal project on SNI had been completed by the end of 2009 (Hanson et al. 2010, 2011). During 2009, IWS had 99 fox patients admitted to the mobile clinic, of which 73 had conditions associated with having been captured in a leg-hold trap (Garcelon 2010). As it was unknown how much additional trapping effort would be required in 2010 to complete the cat removal effort, IWS was asked to maintain the mobile fox hospital on SNI to handle foxes that may become injured in the process of capturing feral cats. Furthermore, there

were still patients in the hospital at the end of 2009 that had been injured during trapping that had occurred in that year (Garcelon 2010), and those individuals needed continued care.

In addition to the veterinary care of injured foxes, IWS was tasked with evaluating the status of the fox population on the island during and after the leg-hold trapping was conducted, and to determine if their were any chronic physical problems associated with foxes that had been caught in these traps. These objectives were accomplished concurrently through capture-mark-recapture efforts both on mini-grids set up in each major habitat type on the island, and by examining foxes captured during annual trapping on the long-term monitoring grids established by the Navy.

This report covers the fox care and population monitoring that was conducted in 2010

METHODS

Estimating Change in Fox Density on the Island

The Navy has monitored foxes on three established trapping grids annually since 2000. This has been the principal means of tracking trends in density, survival and reproduction in the island fox population. Because these grids encompass a relatively small portion of island (18%; Garcelon and Hudgens 2011), and do not include all of the available habitat types present on the island, they cannot be used to detect changes in fox demography on a habitat-specific or a spatially comprehensive basis. In an effort to assess potential changes in fox density across SNI on a habitat-specific basis, we established 26 mini-grids that were configured in a 2 X 6 arrangement with 250 m spacing between traps and operated for four days. This approach follows the recommendations by Spencer et al. (2006) for island fox monitoring, and that used by the National Park Service for monitoring island foxes on San Miguel and Santa Rosa islands (Coonan 2010).

The mini-grids were placed within each of the following habitat types: coreopsis forest, grassland, coastal dune and coastal scrub. We placed additional grids in what was classified as “Barren” areas, which constituted habitat that was primarily void of vegetation and was dominated by rocky exposed soils. To the degree possible, the grids were oriented such that all of the traps were encompassed within one habitat type, although this was not always possible due to the irregular nature of some habitat patches (Figure 1). To avoid capturing foxes on more than one grid at a time when trapping multiple grids concurrently, we scheduled trapping such that grids directly adjacent to each other we not operated at the same time.

We determined the density of foxes on each mini-grid using Program DENSITY (Efford 2004). This spatially-explicit method for density estimation uses a probability model for capture data that explicitly incorporates the spatial component of the sampling process (i.e., the location of each capture) within a maximum likelihood framework. That probability model is comprised of 2 submodels: 1 for the distribution of animals exposed

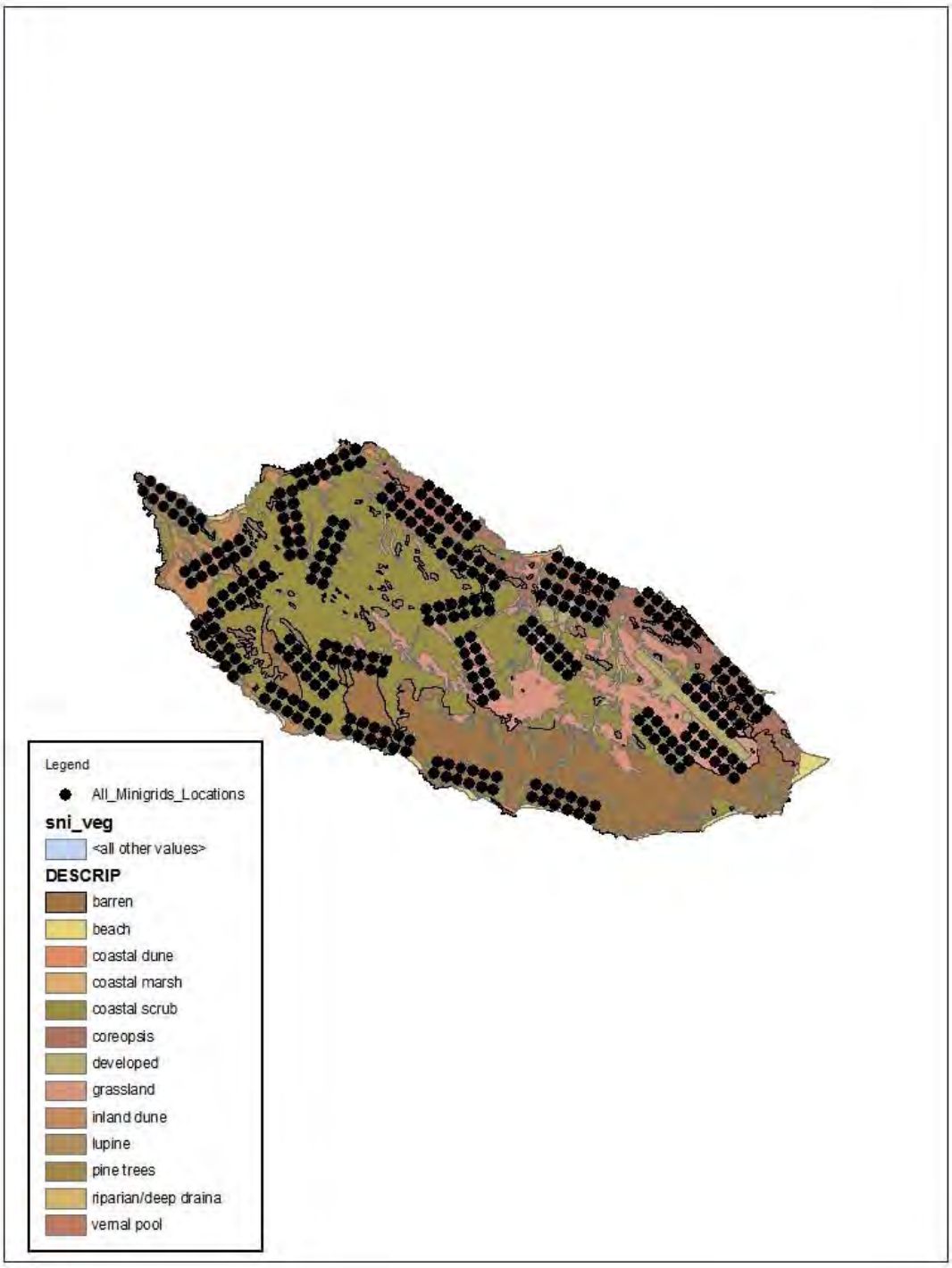

Figure 1. Location of 26 mini-grids trapped on San Nicolas Island in 2010 with associated habitat types.

to the sampling grid and 1 for the detection process. The detection submodel describes the probability of detection of an animal, given the location of its home range in relation to the sample sites. The form of the detection submodel and associated parameters is dependent on the chosen detection function. Additional types of variation in the detection process (e.g., time variation, behavioral response, and individual heterogeneity) can be modeled similar to closed population models. Because this method is likelihood based, AICc (Akaike Information Criterion, corrected) can be used for model selection and model averaging. We ran competing models and selected the model with the lowest AICc weight.

RESULTS

Foxes Presented to IWS by IC During 2010

Six foxes were brought to IWS between 1/11/10 and 1/15/10. Two of the foxes (E720E and 41534) had injuries or conditions not related to the day they were captured and were just brought in for examination. Another fox (0683B) was found to be coughing while in the trap, but no abnormalities were found and the fox did not exhibit the behavior again while held in the clinic.

One AC2 female fox (95A3A) had a possible dislocation of a metatarsal and was held 5 days for cage rest. An AC2 male fox was found to have some laxity in its carpus joint and was held 2 days for cage rest. The last fox (3003F), an AC1 male, was found with the trap chain wrapped around its capture leg. The fox was treated for swelling and held over for 25 days for observation and recuperation.

We completed treatment and rehabilitation of two foxes captured in leg-hold traps in 2009, and these animals were released in 2010. One was an AC4 male originally admitted with a metatarsal fracture on 7 August 2009, who was released on 18 February 2010. The second was an AC4 male that was admitted on 1 November 2009 with hyperthermia and some soft tissue injuries. This animal was released on 20 February 2010. Animals recovering from fractures or long-term stays at the clinic were place in outdoor pens to retain their strength prior to release (Figure 2).

Figure 2. Set of 4 outdoor pens were used to allow fox patients to exercise prior to release.

Mitigation Foxes Treated and Feral Cats Cared for in 2010

In addition to the six foxes brought in by IC in January, we admitted another 11 foxes to the clinic during 2010 as mitigation cases. These were individuals that were not associated with the leg-hold trapping effort, but were discovered with injuries either through other trapping efforts conducted by IWS or by island residents. The injuries ranged from very serious (fractures caused by car collision) to relatively minor puncture wounds (Table 1). These patients represented a total of 487 patient-days in the clinic associated with their treatment and rehabilitation (Table 1). Including the patients held over from 2009 and the foxes brought in by IC for evaluation or care, there were a total of 610 patient-days in the clinic in 2010. No feral cats were trapped in 2010, therefore IWS received no cats to care for during that period.

Table1. Fox patients handled at mobile veterinary clinic in 2010 that were classified as mitigation cases (i.e., not associated with leg-hold trapping).

Fox ID	Sex	Age	Date Admitted	Date Released	No. Days at Clinic	Injury or Illness
27336	M	4	1/14/10	1/15/10	1	Old fracture on metatarsals
6193E	M	4	8/11/09	2/18/10	191	Fractured radius
64653	F	3	2/2/10	2/20/10	18	Possible kidney infection
3423F	M	2	7/3/10	7/7/10	4	Infected puncture above eye
07A59	M	2	9/5/10	9/6/10	1	Mouth jammed in wire trap
15135	M	2	6/29/10	10/19/10	112	Pelvic fracture, hip dislocation
67565	F	4	10/20/10	10/22/10[1]	2	Significant trauma to left front foot
50469	M	0	9/30/10	10/28/10[2]	28	Infected puncture above eye
1930B	F	4	10/15/10	11/1/10	17	Fractured tail
B4759	F	0	7/27/10	11/1/10	97	Partially severed foot
B7C70	M	4	10/16/10	11/1/10	16	Abrasions & punctures on legs

[1]Fox was euthanized due to extent of injury.
[2]Developed spinal fracture upon release and was later euthanized.

Follow-up Monitoring of the Fox Population

We conducted trapping efforts across SNI, both as follow-up to the feral cat removal effort and as part of the Navy sponsored annual island fox monitoring. As part of the annual fox monitoring on the three established trapping grids, we captured 112 foxes during 888 trap nights (Garcelon and Hudgens 2011). During that effort we were able to reassess 69 foxes that had been previously captured in leg-hold traps. The assessment involved testing the mobility of each of the leg joints and palpating for healed fractures above and below the joints.

In addition, we also set up a number of "mini-grids" across the island in 2010 to both examine foxes previously caught in leg-hold traps and to have a broader sampling methodology from which to assess changes in the fox population that might have occurred due to feral cat removal effort (see below). During this effort we captured a total of 192 (155 adults, 37 pups) individual foxes 367 times during 1248 trap nights (29.4%

trap success). Of the 155 adults, 105 (67.7%) had been previously captured in leg-hold traps.

In total, we examined 174 of 437 (39.8%) individual foxes that had previously been captured in leg-hold traps. None of the individuals examined showed signs of joint or long-bone problems that were out of the ordinary. This means that while we did find individuals with crepitation (grinding) and laxity in some leg joints, these conditions are present in the general fox population and could not be easily differentiated from injuries that might have been associated with any previous captures in a leg-hold trap.

Fox Estimation Using Mini-grids on San Nicolas Island

Another goal of the project was to examine near-term changes that might occur in the fox population as a result of the removal of feral cats from the island. IWS proposed that this might best be accomplished by establishing small trapping grids and used capture-mark-recapture methods to determine changes in fox density over time.

During the trapping effort on the 26 mini-grids we captured a total of 192 (155 adults, 37 pups) individual foxes 367 times during 1248 trap nights (29.4% trap success). Density estimates for Barren and Coreopsis habitat grids were very similar in their values (1.91 and 1.89 foxes/km^2, respectively; Table 2), with the highest weighted model being one that provided for combining capture data from all the mini-grids and holding density, detection probability and home range size constant across all grids. The same model was selected for the Scrub habitat, but the estimated density for the 7 mini-grids in this habitat type was considerably higher at 10.3 foxes/km^2 (Table 2). The highest weighted model for density estimation in Dune habitat required separate estimates for each of the five mini-grids, which ranged from 3 – 18.7 foxes/km^2. For Coreopsis habitat, one mini-grid had values that were extreme compared to the other five. This grid was adjacent to Nictown, where human residents are known to feed the foxes and which likely inflates the density for that particular grid. The highest weighted model with all Coreopsis grids run together was one that had separate estimates for each mini-grid. When the Coreopsis-D mini-grid removed from the analysis, the best model combined the remaining mini-grids providing one density estimate of 3.1 foxes/km^2. We then estimated density for the Coreopsis-D grid separately and obtained an estimate of 10.5 foxes/km^2 (Table 2).

Table 2. Capture results for mini-grids trapped on San Nicolas Island in 2010 and density estimates produced using program DENSITY. Where more than one grid within a habitat type is listed, the best fit model required individual estimates for each grid.

Habitat/Grid	No. Grids	No. Indiv.	Total Captures	ML Density Foxes/km^2	Density SE	Density Lower 95% CI	Density Upper 95% CI	Detection Prob. (g0)
Barren	4	16	28	1.91	0.81	0.86	4.22	0.20
Grassland	4	27	47	1.89	0.66	0.79	3.67	0.129
Scrub	7	65	96	10.28	2.00	7.05	14.99	0.049
Dune - A	1	10	23	5.54	1.84	2.93	10.46	1.000
Dune - B	1	14	17	18.72	9.20	7.52	46.60	0.102
Dune - C	1	18	42	11.83	3.02	7.23	19.35	0.578
Dune - D	1	21	36	14.41	4.14	8.30	25.02	0.245
Dune - E	1	6	17	2.99	1.35	1.29	6.94	0.999
Coreopsis	5	23	30	3.0925	1.8668	1.0371	9.2212	0.07089
Coreopsis - D	1	24	31	10.478	16.7861	1.1493	95.5287	0.03631

DISCUSSION

Fox Patients

Due to the fact that IC only operated leg-hold traps for a 5-day period in January 2010, there was only a short period when foxes were exposed to these traps and had any opportunity to become injured. However, IWS maintained the clinic in operation until it was determined by the U.S. Fish and Wildlife Service that the likelihood was low of any further leg-hold trapping occurring. During the period between when IC ceased leg-hold trapping, and when the operation of the clinic was shut down on 1 November 2010, we were able to continue providing care to foxes that had been admitted as mitigation cases. The last of the foxes that were being held for care and rehabilitation were released on 1 November 2010. From the start of the project in June 2009 through October 2010, the clinic took in a total of 116 island fox patients for examination and/or veterinary care. In addition, we provided health checks and care for 52 adult cats and 10 kittens that were born to three adults cats at our facility. All of the cats were successfully transported off of SNI and received by the HSUS for transport to their holding facility.

Population Monitoring Using Mini-Grids

The only comparison we can make for fox density estimates on San Nicolas Island are the results obtained from the annual grid trapping that has occurred on the island since 2000. There some problems associated with direct comparison to those data, as the larger grids (48-50 traps each) used for that monitoring encompass more than one habitat type (Garcelon and Hudgens 2011).

Fox densities found on the Grassland and Barren habitat mini-grids were encompassed within the 95% confidence intervals for the density estimates found on the a primarily grassland grid (Skyline) trapped during the Navy's annual fox monitoring. In 2009 the density estimate was 3.53 (95% CI = 1.9 – 6.5 foxes/km^2) and in 2010 was 3.3 (95% CI = 1.9 – 5.7 foxes/km^2) (Garcelon and Hudgens 2011). The Scrub habitat mini-grids are similar to the predominant habitat on the annually trapped Tuft's grid, and the estimated density on our mini-grids fell within the 95% CI for Tuft's grid for the 2008-2010 period

(Garcelon and Hudgens 2011). The Dune habitat mini-grids are similar to the Redeye annual trapping grid, but not all of that grid is comprised of dune habitat. Three of the higher density Dune mini-grids (B, C, D) fell within the 95% CI of Redeye grid for the 2008-2010 period.

There were no previous data to compare fox densities specifically within Coreopsis habitat. Based on five of the six grids sampled in that habitat, the quality of that habitat for foxes would appear to be higher than either Barren or Grassland, but is considerably lower than densities in Scrub or Dune habitat. The one exception was the Coreopsis-D mini-grid, which is adjacent to Nictown, the location on the island with the greatest human occupation. We believe the density found on this mini-grid was abnormally high due to the foxes being fed by residents in Nictown and then occupying suitable habitat nearby.

As the mini-grid approach appears to be approximating the densities obtained on the larger annual trapping grids, and give the added benefits of providing great spatial representation of the island and habitat-specific density information, we believe it will be a good method of detecting changes that may take place in the island fox population that might be associated with the removal of feral cats from the island.

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